Wilson's Creek National Battlefield

Republic, Missouri

Cultural Landscape Report

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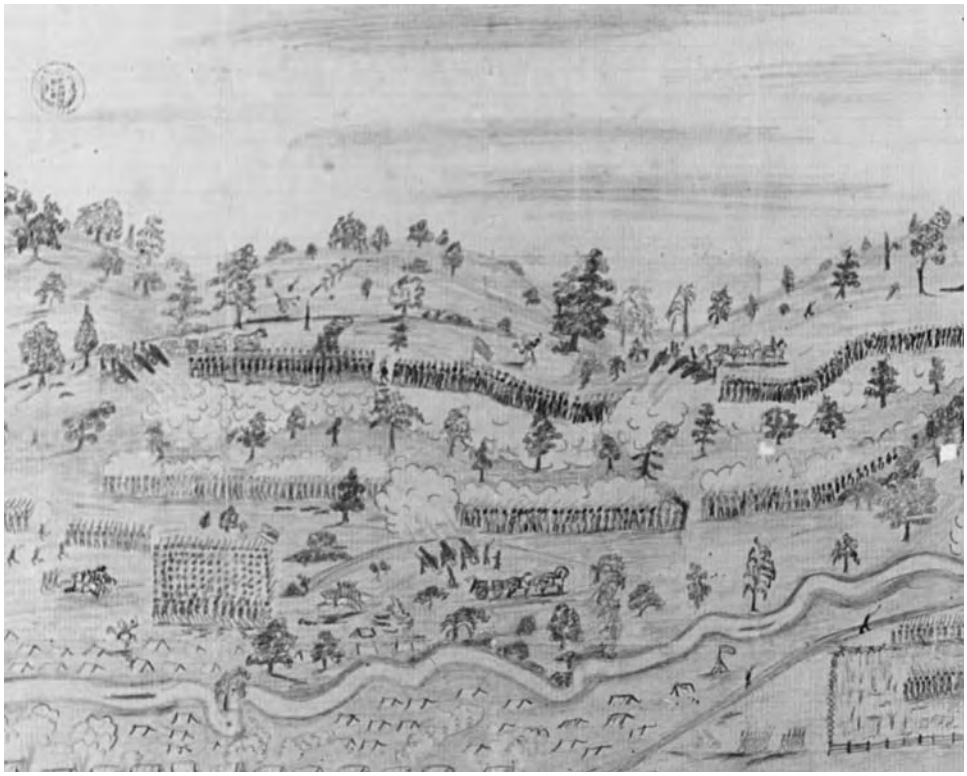

Chapter Six • Treatment Recommendations

CHAPTER SIX

TREATMENT RECOMMENDATIONS AND GUIDELINES

Introduction

The treatment recommendations and guidelines that comprise this chapter were prepared to provide Wilson's Creek National Battlefield (NB) with an overall vision for the park's cultural landscape that will sustain long-term management and interpretation. They arise from a synthesis of work undertaken by John Milner Associates, Inc. (JMA) and their subconsultants to prepare this Cultural Landscape Report (CLR), and consideration of the park's recently completed General Management Plan (GMP). Although this CLR is not intended to duplicate the work of a Long-Range Interpretive Plan, the connection between management of the park's cultural, natural, and historic resources and interpretation became a focus of the treatment recommendations, particularly as they addressed the objectives of the GMP's preferred management alternative. The treatment recommendations also seek to address the needs identified in various park planning documents, including the 1986 *Resources Management Plan*, 1986 *Statement for Management*, and the management issues outlined for the CLR team by former Superintendent Luscardi, which comprise Chapter 5 of the CLR.

This treatment chapter is organized into the following six sections:

1) General Management Plan-Related Guidance, which provides an outline of management issues and recommended actions as described in the park's GMP;

2) Recommended Treatment Approach, which outlines the four alternatives recognized by the Secretary of the Interior for treating historic landscapes, and provides an overriding recommended treatment approach for the Wilson's Creek NB landscape. It also provides the rationale for the selection, and describes why the other alternatives were not selected;

3) Treatment Concept, which outlines the overarching philosophy or approach that drives the treatment recommendations, guidelines, and their implementation. The treatment concept is illustrated on *figure 90*;

4) Treatment Considerations, which describes the issues associated with each landscape characteristic and presents guidelines that apply to the park as a whole, regardless of any alternatives-based choices that are made by the park;

5) General Treatment Recommendations and Guidelines, which identifies the recommendations for the park as a whole that should be considered as part of any future landscape treatment; and

6) Management Zones and Zone-Specific Treatment Recommendations, which identifies and describes various landscape management zones for the park, and the treatment recommendations that apply to each. Implementation guidelines relating to the treatment recommendations are elucidated in Chapter 7. The management zones are illustrated on *figures 91 and 92.*

General Management Plan-Related Guidance

The park's purpose, as stated in the GMP, is "to commemorate the Battle of Wilson's Creek and to preserve the associated battlefield."[1] To fulfill this purpose, the park established four goals as part of their general management planning process:

- protect, restore, and maintain the park's natural and cultural resources and associated values in good condition, and manage them within their broader ecosystem and cultural contexts;
- ensure that visitors safely enjoy and are satisfied with the availability, diversity, and quality of park facilities, services, and appropriate recreational opportunities; and that visitors and the general public understand and appreciate efforts to preserve the park and its resources;
- conserve natural and cultural resources through formal partnership programs; and
- use current management practices, systems, and technologies to better preserve park resources, provide for public enjoyment, and accomplish the park's mission.

To effect these goals, the 2003 GMP presents a series of management alternatives for the park landscape. The outcome of the GMP process was the identification of a preferred management alternative for the Wilson's Creek NB landscape. Titled "Wilson's Creek Battlefield Commemoration," the alternative recommends that park management focus on "efforts to commemorate the Battle of Wilson's Creek and emphasize a reflective and contemplative visitor experience. Recreational use would be allowed but would be managed so as not to conflict with the core mission of the park or the primary visitor experience."[2] According to the GMP, this alternative best addressed the primary objectives and issues requiring management action at the park, including:

- reconciling increasing levels of recreational use with the park's core mission to commemorate the battle;
- minimizing the effects of encroaching suburban development on the park's boundaries;
- continuing efforts to enhance the historic appearance of the battlefield landscape;
- refining cultural and natural resource management strategies;
- maintaining the integrity of the visitor experience; and
- planning cooperatively with neighboring city and county governments.

The GMP also documents the desired future condition of the park, based upon National Park Service (NPS) and general public input:

- preserving and retaining the historic appearance of the battlefield landscape;
- coordinating cultural and natural resource management strategies at Bloody Hill;

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[1] NPS, *Wilson's Creek National Battlefield Final General Management Plan/ Environmental Impact Statement* (Washington: U.S. Government Printing Office, 2003), 15.
[2] NPS, *Wilson's Creek National Battlefield Final General Management Plan*, ii.

- forging partnerships with neighboring landowners;
- coordinating park planning with the planning efforts of local agencies;
- identifying sites for recreational activities as alternatives to Wilson's Creek NB; and
- ensuring that all visitors understand and appreciate the significance of Wilson's Creek NB.[3]

Finally, the GMP identifies a series of resource-specific desired conditions that have a direct bearing on the development of the CLR treatment recommendations. These include:

- management of invasive plant species and rehabilitation of the battlefield landscape with native species will continue as priorities for park management. Invasive plant species would be contained, and gradually replaced by native vegetation;
- some lands significant to the battle lie outside the park boundary. These would be protected through acquisition and easements;
- the cultural resources at Wilson's Creek NB would be protected, and their integrity preserved. Park visitors will recognize and understand the value of the park's cultural resources;
- Wilson's Creek would retain its ecological integrity, including natural resources and processes. The natural features of the park would remain unimpaired, and its prairie and hydrological systems would be rehabilitated to a functional level. The park's limestone glades and mature upland woodlands would be preserved as significant resources. Natural resources will be managed in support of the interpretation and rehabilitation of the historical cultural landscape. NPS personnel will use the best available scientific information and technology to manage the park's natural resources.
- as a result of the cultural and natural resource management described above, Wilson's Creek should be recognized as an outstanding example of resource stewardship, conservation, education, and public use;
- the NPS will continue to work with local agencies and adjacent communities to improve the water quality of Wilson's Creek; and
- the resource management program at Wilson's Creek NB would support the natural distribution and abundance of federally and state-listed species of plants and animals.

The preferred alternative of the GMP focuses on the integrated management of the park's cultural and natural resources to achieve a close approximation of the historic scene on August 10, 1861, while utilizing sustainable and ecologically sound principles. It also assumes an increase in the number of visitors. The challenge of this approach lies in the establishment of an appropriate balance between the needs of existing resource types.

[3] NPS, *Wilson's Creek National Battlefield Final General Management Plan*, 3-4.

Recommended Treatment Approach

The Secretary of the Interior currently recognizes four appropriate treatment alternatives for historic landscapes: preservation, rehabilitation, restoration, and reconstruction. These are defined and discussed in the NPS guidance document, Director's Order #28: *Cultural Resource Management Guideline*, as well as *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*, as follows:

Preservation: the act or process of applying measures necessary to sustain the existing form, integrity, and materials of a historic property. Includes stabilization work, where necessary, as well as ongoing preservation maintenance and repair of historic materials and features.

Rehabilitation: the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.

Restoration: the act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by removing features from other periods in its history and reconstructing missing features from the restoration period. The limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a restoration project.

Reconstruction: the act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.

Based upon the park's need to meet current and projected-future functional, maintenance, and management goals, **rehabilitation** is recommended as the overarching approach to resource management at Wilson's Creek NB. Because rehabilitation is defined as "the act or process of making possible a compatible use for a property," this approach will allow for the enhancement of interpretive opportunities, ecological maintenance and restoration, and visitor amenities, among other objectives outlined in the GMP. Many of the actions proposed in the GMP will require sensitive alterations to the landscape. These changes are most consistent with the rehabilitation approach. Rehabilitation allows for stabilization, protection, and preservation of historic resources, in addition to the limited accommodation of new uses. As part of the treatment recommendations, those resources and systems at Wilson's Creek NB that are suited to stabilization, protection, and preservation are noted. Many aspects or areas of the battlefield landscape are particularly sensitive to change and disturbance and require careful consideration. Sensitive habitats and biotic resources, for example, should be treated with great care. In addition, the CLR recommends preservation of archeological resources, unless a compelling research question or informational need justifies disturbance or excavation, or mitigation to accommodate unavoidable change is necessary.

In considering the other approaches recognized by the Secretary of the Interior for the Wilson's Creek NB landscape, each is considered inappropriate for specific reasons. Preservation is overly restrictive because it does not allow for the enhanced interpretation and site access recommended in the GMP. Restoration and reconstruction are also inappropriate for the Wilson's Creek NB

landscape because they assume, as a prerequisite, that sufficient documentation exists to accurately portray a lost historic condition. At this time, it does not appear that there are documentary sources detailed enough to support restoration or reconstruction of the Wilson's Creek NB cultural landscape.

Secretary of the Interior's Standards for Rehabilitation

The following section summarizes the standards for rehabilitation espoused by the Secretary of the Interior for historic properties. The ten basic principles that comprise the standards are intended to help preserve the distinctive character of a site, while also allowing for reasonable change to meet new needs. The standards (36 CFR Part 67) apply to historic properties of all periods, locations, sizes, conditions, and uses. These standards create a baseline of guidance to which intended changes to the historic landscape must be compared. These standards are neither technical nor prescriptive, but promote responsible preservation practices, as follows:

- A property will be used as it was historically, or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.

- The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

- Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.

- Changes to a property that have acquired historic significance in their own right will be retained and preserved.

- Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

- Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.

- Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

- Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

- New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

- New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Treatment Concept

See figure 90, Treatment Plan, at the end of this section.

The treatment recommendations for Wilson's Creek NB provide a vision for the site as a whole, as well as site-specific guidance for individual resources. This section is intended to convey the overarching vision or concept for treatment, within which the more specific recommendations that follow can be understood.

The overarching concept for cultural landscape treatment at Wilson's Creek is to balance the park's desire to protect and enhance the battlefield's commemorative and contemplative qualities with the need to establish contemporary features and activities that support the comfort, enjoyment, and safety of the public.

Vegetation and natural resource management, interpretation, and planning for future development and increased visitation are the main focus of these treatment recommendations, as they are the highest-priority needs identified by the park in its GMP. First and foremost, rehabilitation and restoration of the natural systems at Wilson's Creek NB are recommended to support preservation of the site's cultural resources and historic integrity. The park's current landscape is the result of years of intensive agriculture, livestock grazing, fire suppression, park use, and site improvement activities. The combination of intensive shading, loss of soil organic matter, and dramatic increases in stormwater run-off throughout the system has continued to cause what can best be described as a rapid collapse in the natural systems present at Wilson's Creek. The NPS has a unique opportunity to rehabilitate the landscape and park infrastructure in a sustainable manner, at the same time enhancing it historic integrity. Interpretation of this effort would also benefit the public, and is consistent with the goals of the park's GMP. The recommended approach to vegetation management will also support a crucial interpretive goal at the park: enhancement of visual accessibility. Removal of the existing weedy thickets and densely wooded areas through rehabilitation of historic prairie and savanna plant communities will serve to open up views of the battlefields in many key locations. Implementation of appropriate landscape restoration approaches and techniques, and use of contemporary technologies in the planning and implementation of sustainable architectural and civil engineering projects, will support the park's goal of more closely approximating 1861 conditions.

Rehabilitation of existing vegetation communities focuses on the native species enhancement of existing prairie restoration areas to increase biodiversity, and clearing, thinning, and rehabilitating existing thickets and young woods to more closely approximate historic savanna conditions *(see figure 93, Park Plant Communities map).* At the time of the battle, much of the landscape was characterized by open fields of native grasses, and savannas of grasslands dotted with open-grown deciduous hardwood trees. Today, young woodlands occupy much of the site. These woodlands are comprised primarily of adventive species, such as multiflora rose, and thickets of undesirable weed trees, such as white mulberry (*Morus alba*), red mulberry (*M. rubra*), and American elm (*Ulmus americanus*). Rehabilitation of these plant communities to promote species consistent with a savanna will increase visual accessibility and improve the ecological health of the park. Fibrous-rooted grasses will promote infiltration of surface water, benefiting the entire community, and removal of thickets of trees will increase light levels to support more desirable plant species. Removal of adventive plants will enhance biodiversity. Of particular importance is rehabilitation of

the glades, and the mature woodland in Manley woods, both of which represent rare remnant communities.[4] The treatment recommendations provide the means for enhancing the viability and health of these communities, and suggest relocating interpretive programs and other incompatible visitor and park uses away from these sensitive areas as a protective measure.

In addition to vegetation and natural resource management, the treatment recommendations address trail and exhibit development. Coupled with treatments that enhance visual accessibility are recommendations for extensive new trail systems to increase interpretive opportunities within the park. The proposed trail system—conceived as a series of pedestrian loops initiating along the Tour Road—focuses on recalling historic road traces and routes that were important to the battle events of August 10, 1861. In most cases, the trails are intended to link new interpretive exhibits that portray now-missing features that played a role in the battle, and to convey the military tactics of the battle. The CLR recommends weaving interpretation of all significant layers of history that have occurred on the site—including American Indian and early settler occupation, and industrial and commemorative uses that occurred after the battle—into these new experiences. Also proposed is the establishment of contemplative nodes at various locations within the park. These nodes would be located along the trail system at the sites of important locations associated with the battle. They would be designed as quiet refuges, with comfortable seating areas provided for visitors.

The treatment recommendations suggest general locations and guidelines for establishing, altering, and adjusting the existing trail system at the park, including equestrian trails as well as pedestrian trails. As illustrated, the concept for park trails accommodates equestrian uses. The GMP indicates a need to relocate the equestrian parking and staging area. In the treatment recommendations, a new horse parking and staging area is proposed to the north of the Visitor Center complex along Route 182. Access to existing equestrian trails is recommended through the adaptation of the existing Edgar Spur Trail for equestrian use, which leads horseback riders from the parking and staging area to a new loop system of equestrian trails that incorporates existing trails, connected via new segments.

Pedestrian circulation is proposed as a series of five loop trails with trailheads located at parking pull-offs along the Tour Road. The loops are designed to provide access to features of the 1861 cultural landscape and the locations of important events associated with the Battle of Wilson's Creek. Many of the loops incorporate existing pedestrian trails into a larger system, but also include new trail segments, many of which follow historic roads or road traces. The five loop trails that comprise the proposed pedestrian system are described in the recommendations later in this chapter and in Chapter 7 implementation projects. Also see the Treatment Plan, *figure 90,* at the end of this section.

[4] Remnant plant communities are those tracts of land that have passed from the pre-settlement period to the present without having been tilled, pastured out completely, or shaded out to the point where soil is lost to oxidation or erosion. The higher-quality remnants provide the habit for conservative plant species that are rarely found elsewhere.

Treatment Considerations by Landscape Characteristic

This section summarizes the treatment issues that pertain to different landscape characteristics and management concerns within the park. It is intended to lay out the opportunities and constraints associated with each of the landscape characteristics addressed as a part of this study, and describe the issues that have influenced the development of the more specific management guidelines and treatments included later.

Spatial Organization

Rehabilitating the spatial organization in the park to its appearance during the Battle of Wilson's Creek is a key component of the park's interpretive vision. Rehabilitation of 1861 field and fence patterns, woodlands and savanna, circulation corridors, apple orchards, cornfields, and the identification of missing farmstead clusters will engender for visitors a greater understanding of the battle and its importance.

Natural Systems and Features

Wilson's Creek NB contains numerous natural systems and features, many of which are in a degraded condition. The park's natural systems and features need to be stabilized before they can be restored. With the use of adaptive management principles, the natural systems can begin the process of recovery. Adaptive management recognizes that natural systems are constantly changing and that in order to achieve the highest level of health and stability, land managers must adapt their practices to these changes.

While the park's ultimate goal is scene rehabilitation, it must be achieved through implementation of Best Management Practices (BMPs) for natural resources. For example, water resources need to be managed to prevent further erosion and sedimentation, and fallow fields, scrubby woodlands, and colonies of adventive species to be rehabilitated to support healthy communities of non-invasive, native plants. The sensitive habitats of endangered plant and animal species, such as the Missouri bladderpod and gray bat, need to be protected and enhanced. Also critical is the protection of the park's contributing topographic features—including Bloody Hill and the various knolls—which played key roles in the Battle of Wilson's Creek. In addition to their protection, providing visual accessibility for visitors to these key landforms is a primary objective of treatment.

Treatment considerations for specific natural resource types include:

> **Springs**: The springs that were once a common characteristic of the Wilson's Creek drainage have either dried up or are mere trickles. The chronic loss of vegetation with fibrous root systems capable of slowing, capturing, and infiltrating rainwater into the soil, along with the resulting loss of soil organic matter, now cause precipitation to become surface water run-off. There is no doubt that the general lowering of the water table in the surrounding area is not helpful for sustaining springs. In other areas, however, springs have returned when surrounding agricultural lands were placed in grassland cover, and phreatophytic trees were removed.[5] The way in which the watershed of the spring receives and handles rainfall is relevant to the health of the associated springs, thus making vegetation and land use management critical. Springs will

[5] Phreatophytic plants are deep-rooted, obtaining water from a permanent underground supply or the water table.

return and improve in quality with the restoration of healthy plant communities within the watershed of each spring. All water that falls on the site should be infiltrated. This can only be achieved if the ground is covered by native sedges and grasses. While infiltration may occur in areas where graminoid vegetation has not been successfully established, the springs will become polluted with phosphates and nitrates due to leaching. When native organic matter is well established, water will infiltrate without stripping away nutrients, even during the winter months. By stabilizing the watershed with native vegetation, the health and flow of the springs can return.

Hydrology: Historically, most of the precipitation that fell in the watershed, even during the most violent rain events, percolated into the ground.[6] Surface water run-off was rare prior to agricultural production, and the enormous floods characteristic of Wilson's Creek today did not occur. Today, precipitation in and adjacent to the park is no longer infiltrating on site and recharging underground springs, but instead becomes surface run-off. As this water travels over and erodes the soil, it carries with it valuable natural resources and cultural artifacts. The effects of years of sedimentation are evident in the growing floodplain and continuing erosion in associated watersheds of Wilson's Creek and its tributaries. Significant amounts of water move through Wilson's Creek and its tributaries at velocities the system cannot withstand; therefore, the watershed must be stabilized and restored. In addition to the loss of vital resources through soil erosion and leaching, the quality of water within the creeks is also of major concern. Pollutants from wastewater treatment malfunctions, run-off from urban development, and chemicals and fertilizers from surrounding agricultural fields have contributed to the toxicity of the water that runs through the park. Stabilization of the watershed within the park's boundaries using deep-rooted native vegetation is a key goal of CLR treatment recommendations. It will also be necessary to engage and encourage owners of adjacent properties that contribute to the creek's watershed to manage their land in a sustainable manner. A model of the watershed needs to be developed and analyzed with appropriate treatments and strategies implemented to rehabilitate Wilson's Creek and its tributaries. Water quality will improve as soil erosion and run-off are minimized, both on site and off site.

Riverbanks, terraces, and gravel bars: These areas, once associated with the flow of Wilson's Creek, were characterized by relatively well-watered but well-drained alluvium or gravel, and consisted mainly of meadows of mesic prairie interspersed with open-grown trees. The higher terraces were once the ecotone between the riverbanks and upland savannas. Over the years they have become buried under sediment or reworked by scouring and local erosion. As with the riverbank systems, vegetation is notably Eurasian, with dense thickets of weedy trees. The higher terraces are less likely to flood, increasing the chances that efforts to reestablish native groundcover will be successful. The treatment of this area is not possible until broad factors within the watershed area (described above) are addressed. When the watershed becomes stabilized, the park may consider removing sediment from these areas and restoring the historic flow elevations of Wilson's Creek. Since artifacts are likely contained within the layers of sediment, the process would need to be carefully planned and implemented. The stabilization of the watershed would also make it more feasible to implement various BMPs for stormwater management and treatment. These water resources will improve in quality with the restoration of healthy plant communities within the park and its associated watershed. Once the watershed becomes stabilized, BMPs can be used to reestablish and protect the banks and terraces within Wilson's Creek and along its tributaries. The habitat in which native sedges and grasses are encouraged to grow and proliferate would be returned to these areas, further stabilizing the watershed and all of its resources.

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[6] James Patchett and Gerould Wilhelm, "The Ecology and Culture of Water" (Elmhurst, IL: Conservation Research Institute, 1999).

Vegetation

Sensitive rehabilitation of vegetation communities in the park is a necessary component of scene rehabilitation. The GMP and CLR both suggest that vegetative composition and density have been greatly altered since the 1861 period of significance. In addition to hindering interpretation efforts, current vegetative composition is not sustainable. The treatment recommendations include suggestions for clearing and thinning operations to return the dense woodlands to their historically more open character; the removal and monitoring of adventive—or invasive—plant species; the addition of warm season grasses where fallow or fescue-covered fields now exist; and the potential enhancement of prescribed fire activities. While all of the plant communities within the park have undergone post-settlement disturbance, Manley woods and several glade areas are "remnant" landscapes. Remnant landscapes are irreplaceable and there are specific treatment recommendations that support their protection. Considerations associated with many of the individual communities present within the park are discussed in more detail below. Specific guidelines for the implementation of restoration activities, including desired results such as tree densities for savannas, glades, mixed forest, and prairie communities, can be found in Chapter 7.

Savannas: Characterized by widely spaced open-grown trees, savannas have a relatively rich flora. Their composition is underlain fundamentally by sedge species, which, like the grasses of the prairie, form two essential matrices in the system. Soil organic matter is sustained by their fibrous root systems, and the aboveground fine fuel produced by their leaves controls the intensity and nature of the ground fires that sustain them.

The savanna communities at Wilson's Creek have been overwhelmed by shading, fire suppression, and agricultural practices. Degraded remnants of the mesophytic savannas occur on the northern exposures of the bluffs along Skegg's Branch and to some extent along the northeastern and eastern exposures along Wilson's Creek south of the power line crossing. There is a relatively high quality remnant of savanna along the west-facing bluffs of Wilson's Creek. Unfortunately, Manley woods was greatly impacted by a tornado that cut through the park in May 2003. The proliferation of young, even-aged trees growing at high densities greatly threaten the existence of these areas. The savannas can be rehabilitated to a functional level with the restoration of aboriginal light levels. In those areas with a sufficient fuel load, this can be achieved by annual fire alone, while in others the selective clearing of trees will be necessary to open up the canopy and return the native grasses and sedges (i.e. fuel loads) that had been shaded away. There are areas within the park that currently have the fuel load to burn annually. Site-by-site assessments of available fuel load will best be made by park staff, and reflected in the prescribed fire management plan. In more degraded areas, the frequency of fire will increase as they begin to recover. Ironically, the areas affected by the 2003 tornado may now have appropriate light levels to regenerate these important groundcover species. It is critical, however, that clean up of these areas begin as soon as possible to minimize the setback of the restoration efforts that have occurred in Manley woods to date. A delay in the cleanup of downed woody material will cause further shading of the ground, resulting in continued loss of sedge root mass, soil, and other important resources through sheet erosion.

Frequent prescribed fire cycles will be necessary in the restored savannas to control the growth of saplings and adventive plant species that will threaten to shade away fuel species. Management of these areas will become progressively more expensive if left untreated. With the application of appropriate treatments, the open-grown trees and proliferation of native grasses, sedges, and forbs (wildflowers) will be evocative of the historic scene. Remnant biodiversity will return to the landscape along with the health and stability of the overall watershed.

Mixed Forest: Likely once prairie/savanna landscapes, these areas of dense trees are nearly devoid of native groundcover plant species. This shading of the groundcover has resulted in a loss of deep-rooted native sedges and grasses, which once functioned to sustain soil organic carbon and infiltrate rainwater. The drastic reduction in light levels over time has resulted in exaggerated and greatly accelerated rates of soil loss and erosion. As in the savanna communities, these areas can be rehabilitated to a functional level with an increase in light levels. This will require the selective clearing of trees to open up the canopy and return the native grasses and sedges that have been shaded away. Prescribed fire will be necessary to control the growth of saplings and adventive plant species that threaten to shade out any fuel matrix. The frequency of fire will increase as areas begin to recover and fuel loads return. In general, due to years of intensive shading, these areas will likely respond slowly to the application of appropriate treatments. With time, open-grown trees will reappear and the native flora will return to the system, bringing the site closer to its 1861 appearance. Native species' richness will return to the landscape and the health and stability of the overall watershed will continue to improve.

Glades: The glade community once characterized all areas where limestone was near the surface on south-, west-, and northwest-facing slopes. Once nearly treeless, the glades are now threatened by a proliferation of Eastern redcedar (*Juniperus virginiana)*. Currently, Eastern redcedar trees are colonizing many of the glades, shading out native species and cooling the substrate below. This cooling effect changes the mass-heat relationships of the exposed bedrock on which native glade plant and lichen species are dependent. The shaded conditions have allowed for a proliferation of adventive Eurasian species, such as cheat grass (*Bromus tectorum*) and Japanese honeysuckle (*Lonicera japonica),* which will require management. Although scarcely resembling their former extent or character, the glades still retain a number of conservative herbaceous species and should be classified as significant natural features to be protected.[7] The ambient treatment of the savannas and prairies will enhance the richness and sustainability of the glade systems interspersed among them. If managed as continuous units, these areas will become healthier, increasing the potential habitat for the park's endangered plant species, particularly the Missouri or narrow-leaved bladderpod (*Lesquerella filiformis*).

Prairie and Savanna Rehabilitations: About thirty-five years ago, early attempts at prairie restoration began at Wilson's Creek NB, and were ongoing until the mid-1990s. The majority of the species used to seed the restoration areas have been warm season grasses, such as little bluestem (*Schizachrium scoparium*), big bluestem (A*ndropogon gerardii),* and Indian grass (S*orghastrum nutans).* In those areas where prescribed fire has been relatively frequent, the warm season grasses predominate. Some areas are infested with the adventive Sericea lespedeza (*Lespedeza cuneata*), however, which is not affected by fire and has become a major management concern in several locations throughout the park.[8] With continued stewardship and enhancement, these areas will continue to develop greater biodiversity and system stability.

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[7] The term "conservative" as it applies to native plant species in this report means those that are known to exhibit strong affinities for certain plant associations, soils, and geography.

[8] This statement is based on discussions with the park's Chief of Resources and Facility Management Gary Sullivan about his experience at the park using fire to control this species. The Nature Conservancy website supports this assertion as well: "Spring burns are not effective for controlling the spread of *L. cuneata*, as new shoots sprout almost immediately after fire. Dormant season controlled burns can also promote *L. cuneata*. Fire scarifies seeds of *L. cuneata*, promoting germination and seedling establishment on open, bare ground." An adaptive management approach is based on experience and field observations. If this assertion should change in the future, the invasive species control plan for the site should be revised to reflect the new approach.

Old Field: In restoration areas where fire has been infrequent, the plant community is better described as old field and is generally dominated by a few Eurasian weed species. This plant community was virtually absent prior to settlement. It should be noted that the adventive and weedy species that comprise a majority of these areas, if left unmowed or not burned, will become increasingly dominated by dense thickets of weedy trees and shrubs, which eventually cast enough shade to resume surface erosion. Management of these areas should emphasize prairie restoration, initially using prescribed fire to select for native warm season grasses.

Circulation

The majority of circulation patterns observed today at Wilson's Creek NB are associated with twentieth- century park development. The only known pattern to remain from the 1861 period of significance is the Wire Road. Otherwise, few routes survive that existed prior to park establishment in 1960. Treatment recommendations focus on the retention and maintenance of remaining circulation features, identifying the need for additional research to locate missing circulation routes, and the means for incorporating new trails into the visitor experience that follow former circulation routes. Of utmost importance is the protection, appropriate use, and interpretation of the Wire Road, due to its historic significance. This CLR recommends that other existing historic road alignments, as well as those located through future archeological research, also be adaptively reused. The challenge of enhancing visitor access in this manner will be to ensure that the resources are not altered in ways that result in a loss of historic character. No alterations to existing circulation routes, or establishment of new routes should occur until after compliance is accomplished; new trail planning would include public involvement and review.

Buildings and Structures

Very few buildings and structures survive from the 1861 and 1861–1960 periods of significance. Contributing buildings and structures include the Ray House and springhouse, the McElhaney House, the County Road bridge, and possibly the Short springbox. These features need to be protected and maintained in order to maximize their interpretive potential and protect their integrity. Although the McElhaney House and County Road bridge post-date the 1861 period of significance, they do not detract from the integrity of the 1861 landscape, are likely significant in their own right, continue to be used, and should be retained and maintained. Interpretation of missing buildings and structures should be undertaken appropriately, and without the use of conjecture. Interpretive exhibits, such as brick outlines representing building footprints, or fences and orchard plantings representing former farmsteads would further support visitor understanding of the historic landscape. These should be established based on evidence identified through documentary and archeological research. Treatment recommendations for the Edwards Cabin—a structure that survives from the battle period yet was later moved into the park from a different location—are intended to address the interpretive role of the structure, and its potential to mislead visitors.

Buildings and structures associated with the Town of Wilson Creek between 1905 and 1928 played an important part in the evolution of the landscape, even though they were not associated with the battle. Although restoration or reconstruction of the town is not appropriate, interpretation, through signage or markers, is recommended to help visitors understand this aspect of the history of Wilson's Creek NB.

Views

Views are another key interpretive tool at Wilson's Creek NB, as viewpoints associated with knolls and elevated landforms were a critical component of the tactics used by Civil War-era military commanders. Views to and from Bloody Hill are crucial to interpreting the battle events and should be rehabilitated, while sightlines through the Ray and Sharp farm fields and the fields east of the Edwards Cabin need to be protected and maintained. Views from the beginning of the Tour Road are currently blocked. Providing an initial view into the battlefield landscape for visitors is a goal for treatment. Since there are no extant contributing views, viewshed rehabilitation constitutes a large part of the park's scene rehabilitation efforts.

While the focus of treatment regarding views is scene rehabilitation to approximate the landscape's 1861 appearance, mitigation of intrusive views is also important. Views from the park to adjacent properties are potentially not compatible with the park's goals of reflection, contemplation, interpretation, and commemoration of the Battle of Wilson's Creek, and intrusive views should be mitigated.

Small-scale Features

There are no small-scale features known to survive from the Civil War period of significance and only two features—the etched stone atop Bloody Hill and the Lyon Marker—remaining from the 1861–1960 commemorative period of significance. Others, including the cemetery head- and footstones and stacked stone walls, have not been precisely dated. For all of these small-scale features, a conservative approach to their treatment is recommended, including retaining and maintaining these resources to protect their cultural resource value.

Due to the lack of information about many small-scale features present during the Battle of Wilson's Creek, it will be difficult to interpret missing small-scale features without introducing conjecture. For this reason, if no substantial documentation about a missing feature is available, it is preferable that the park avoid reconstructing it. However, if tangible evidence of a particular feature supports enhanced comprehension of the battle activities, interpretive exhibits that are clearly contemporary, yet illustrate the role of a missing feature, would be appropriate.

Archeological Resources

The entire park should be considered an archeological resource, and any proposed or potential ground disturbance should be examined by archeologists on a case-by-case basis. Appropriate compliance should be conducted prior to implementation of any landscape treatment recommendations that require ground disturbance, including trail establishment or realignment, vegetation changes, orchard plantings, or interpretive exhibit development.

Partnering

The GMP emphasizes the need for partnering and cooperative efforts with local agencies, organizations, and property owners in achieving the park's vision and goals. The CLR recommends fostering relationships with adjacent landowners, local city and county governments, and state and federal Departments of Transportation. Partnering with these entities would be beneficial in terms of coordinating easements, fitting park development goals with municipal comprehensive plans, and influencing the location and design of future roads. Working with adjacent landowners to help

secure and stabilize the watershed is one example of an important partnering effort that should be explored.

Recreational Uses

Another management concern emphasized in the GMP is the need to restrict and mitigate recreational uses within the park in order to preserve and enhance the reflective, contemplative, and commemorative qualities of the park. The GMP expresses concern that the growing populations of the surrounding counties and nearby City of Springfield will lead to a large influx of local residents seeking active recreational opportunities. An increase in the number of visitors who bike, hike, and ride horses may detract from the park's primary purpose of interpreting and commemorating the Battle of Wilson's Creek. The CLR suggests that, if equestrian use of the park leads to onerous maintenance responsibilities due to soil erosion along trails, the introduction of adventive plant species through feed and waste, and safety concerns with pedestrians, horseback riding within the park should be restricted or greatly modified. The CLR treatment recommendations and guidelines provide suggestions and options for mitigating the effects of recreational activities on resources.

New Design and Construction

The GMP identifies new design and construction efforts that may be implemented in the future, including additional parking areas and enhanced interpretive facilities. The CLR includes treatment guidelines and recommendations that address appropriate implementation of these proposed projects so that they are compatible with the historic character of the landscape, and easily distinguishable as contemporary additions; how and where to locate new development; how to guide development on adjacent lands; and to what level new additions can be made without adversely affecting the resources and scene restoration. As noted previously, means for promoting infiltration of precipitation and overland flow of stormwater should be considered an integral component of all new construction efforts.

General Treatment Recommendations and Guidelines

The general management guidelines and recommendations that follow pertain to Wilson's Creek NB as a whole and should be used when planning for any future landscape change. They are intended to support all landscape treatments proposed herein and should be considered in conjunction with any project or treatment alternative that is undertaken at the park. These guidelines relate to a philosophy of cultural landscape treatment based on NPS Director's Order #28: *Cultural Resource Management Guideline*, and the Secretary of the Interior's *Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes*.

Spatial Organization

- Restore field patterns using ecologically sound techniques and BMPs.

- Avoid conjecture when rehabilitating historic spatial organization patterns. Rely on documentary evidence and archeological survey data rather than circumstantial evidence.

Natural Systems and Features

- Model and analyze the overall watershed area that supports Wilson's Creek NB to determine its extent and to develop BMPs and approaches to watershed remediation.
- Rehabilitate and restore native landscapes within the park to eliminate run-off and enhance infiltration of precipitation into the park's groundwater resources.
- Work with neighboring landowners and local agencies to diminish the amount of run-off entering the site through Wilson's Creek and its tributaries.
- Continue, develop, and broaden the prairie restoration program. Incorporate old field landscapes as funding allows.
- Establish a program for the control of specific adventive species that threaten the rehabilitation process.
- Establish performance criteria for each rehabilitation and restoration effort and develop a monitoring protocol that measures the extent to which these criteria are being achieved.
- Monitor the progress of restoration and rehabilitation activities, using the monitoring protocol established for the park. Adapt the techniques and approaches to restoration and management based upon evaluation of the monitoring efforts.
- Develop a prescribed fire plan that maximizes the size of prescribed fire units and attempts to burn annually or as frequently as fuel loads and/or park resources permit.[9]
- Avoid the use of pesticides and herbicides unless absolutely necessary. If chemical controls are used, apply the minimum necessary to achieve the proposed effect. Allow only qualified applicators to apply chemicals.
- Avoid altering topography in the park. Minimal grading for new trails is acceptable, while alterations to Bloody Hill or the gently rolling Ray and Sharp fields are not appropriate.
- Protect slopes from erosion. Maintain a healthy vegetative cover on all slopes.

[9] Although the contemporary doctrine among most ecologists is that fire is a necessary factor in native plant community health, fire frequencies shorter than 3 years are also considered stressful or detrimental to an array of organisms. It appears that this position is based primarily upon short-term studies that log or record the impacts of burning after 2 or 3 years of fire suppression. Indeed, such an accumulation of fine fuel near the surface of the ground can cause slow moving, cooking fires that can burn at different temperatures and moisture levels. Observed decreases in certain species populations are therefore not surprising. Virtually no long-term studies in remnant systems have recorded fire intervals as frequent as those described by the earliest European-American settlers—fires set annually in autumn. In areas where there has been a long-term use of annual prescribed fire—Walpole Island, Fort Bragg bombing ranges, Eglin Air Force Base in Florida, artillery range at Camp McCoy in Wisconsin—species diversity has clearly benefited. The CLR continues to recommend that as much of the park that can be burned should be burned annually, or as frequently as fuel loads and/or park resources permit.

Vegetation

- Develop a vegetation management plan prior to undertaking any changes in the park. Consider carefully the opportunities and constraints associated with prescribed fire, historically-appropriate crop and orchard species, thinning and clearing activities, and other vegetation management issues.

- Employ BMPs for thinning and clearing woodlands. Undertake clearing and thinning operations with the goals of reducing fuel loads, opening viewsheds, and returning the woodland to its approximate composition during 1861.

- Mark all vegetation to be thinned or cleared prior to beginning work. Employ an arborist, natural resource manager, and/or landscape architect familiar with the park to mark the vegetation to be removed or thinned.

- Identify, control, and remove adventive plants.

- Establish a monitoring program to record populations of invasive and adventive plants within the park and utilize data collected to inform ongoing maintenance procedures.

- Maintain and enhance the health and diversity of vegetation in sensitive or remnant communities particularly the limestone glades and Manley woods shown on *figure 93*.

Circulation

- Ensure that no new trails or roads are planned or built within or through any of the sensitive or remnant communities.

- Avoid altering existing circulation routes, or establishing new circulation routes until after compliance has been completed.

- Minimize the visual impacts of vehicles and vehicular access systems. Consider the potential impact on views when planning to add or change circulation systems.

- Make vehicular access as unobtrusive as possible. Consider noise and other impacts when siting parking.

- Consider the possibility of providing a shuttle/bus tour system on peak weekends if traffic and parking become concerns in the future. Direct visitors to park at the main parking area and ride a small, environmentally friendly bus or van along the tour loop on guided or unguided tours, thereby reducing the amount of traffic on the Tour Road and throughout the park.

- Encourage pedestrian or bicycle circulation as an alternative to vehicular access.

- Minimize the visual impacts of pedestrian access systems.

- Develop a conceptual design for trails that provide pedestrian connections to all current or potential interpretive areas in the park. Identify preferred locations for universally accessible interpretive trails, and segments that will, due to terrain and other factors, remain "natural" or unimproved for universal accessibility. Develop the design in conjunction with an assessment of equestrian trail design considerations, and considerations of the Tour Road system of views, interpretive nodes, and trailhead connections to pedestrian routes.

- Take advantage of existing road traces and trail systems whenever possible to avoid disturbance of the historic landscape.

- Design interpretive trail systems to follow the routes of historic road traces and alignments whenever practicable. Consider however, the potential impacts of new trails following these routes. Assess the following: the visual impact of trail on important viewsheds; potential impact on sensitive natural and archeological resources; accessibility issues such as slope; potential for erosion; and overall interpretive value. If issues of concern cannot be mitigated, consider using a different alignment for the trail that fulfills related goals.

- Avoid regrading that will damage historic road traces when establishing new trails along historic routes. Whenever regrading is necessary, use fill that is distinguishable from the existing grade rather than cut, which will destroy the resource.

- Consider alternative interpretive trail alignments if documentary and archeological evidence is insufficient to determine the precise routes of 1861 roads.

- Ensure that the removal of non-historic park trails is undertaken with minimal impact on adjacent features; that visitor maps, signage, and other indications of trail layout are updated to reflect the removal; and that former trail surfaces are seeded or otherwise appropriately revegetated.

- Route visitor circulation away from sensitive archeological resources, cultural sites, and endangered species habitat areas.

- Follow the regulations stipulated in the Uniform Federal Accessibility Standard (UFAS) and Americans with Disabilities Act Accessibility Guidelines (ADAAG) for trails and paths when establishing universally accessible circulation that may be designated as "improved" in the Trail Management Plan proposed above. Avoid steep slopes, ensure that trail width meets regulations, and take other precautions to make these trails accessible to all visitors.

- Provide universally accessible routes to primary interpretive elements. Strive to accommodate universal accessibility to all interpreted features, except where implementation of accessibility will threaten the integrity of the cultural landscape. Provide alternative interpretive experiences where accessibility is not possible or reasonable.

Buildings and Structures

- Preserve, protect, and maintain buildings and structures surviving from the 1861 period of significance. These include the Ray House and springhouse, and possibly the Short springbox.
- Preserve, protect, and maintain buildings and structures surviving from the 1861-1960 period of significance. These include the McElhaney House and various outbuildings, the County Road bridge, and possibly the two stone fences.
- Consider the interpretive value of non-intrusive, non-contributing buildings and structures.
- Consider the removal of non-contributing structures that are intrusive to the historic landscape.
- Remove post-1861 buildings and structures only if they have a negative impact on the historic character and integrity of the park landscape. Document thoroughly all buildings and structures before removal.
- Avoid conjectural reconstruction of missing historic buildings and structures.

Views

- Consider scenic easements on tracts of land adjoining park boundaries as a method of viewshed and resource protection and an alternative to fee-simple land acquisition.
- Minimize the visual impact of pedestrian and vehicular access systems. Consider using techniques such as vegetative screens and depressed grades, alignment of new trails to be invisible from key viewpoints, and minimizing the amount of signage, seating, and other small-scale features.
- Communicate with utility providers regarding future plans to upgrade telephone and utility lines within the park. Suggest that future lines be placed underground and contained within existing easements and right-of-ways.

Small-scale Features

- Provide minimal site furnishings to accommodate visitors, including benches and trash receptacles. Use site furnishings that are compatible with the character of the park in connection to the park's theme and concept and materials. Ensure that the style of site furnishings is uniform throughout the park.
- Keep the number of contemporary small-scale features to the minimum required for visitor and staff comfort and safety.
- Convey interpretive information to visitors primarily through the use of graphically rich waysides that are durable, contemporary in form and character, muted in color, and composed of simple materials.

Partnering

- Consider working with adjacent willing landowners to place conservation easements on tracts of land adjoining park boundaries to protect natural and cultural resources, and as an alternative to fee-simple land acquisition.

- Partner with landowners and local, state, and federal agencies to secure and stabilize the watershed associated with Wilson's Creek. Promote the implementation of BMPs on private parcels associated with the Wilson's Creek watershed, and the establishment of vegetation communities and other features that encourage infiltration of precipitation and overland flow of stormwater.

- Coordinate with local city and county governments to ensure that comprehensive and municipal development plans take into account park policies and goals. In addition, work with agencies to develop a plan for private lands adjacent to the park through Greene and Christian Counties in support of the protection of conservation easements and management of open space and agricultural land uses.

- Coordinate with local, state, and federal departments of transportation to ensure that new roads, or alterations to existing roads, will not adversely impact Wilson's Creek NB.

- Consider using transfers of development rights as a conservation tool.

- Employ strategies for land conservation and partnerships found in *Saving America's Countryside*, a handbook for land development.[10]

- Apprise neighboring property owners of prescribed fire schedules.

Land Uses

- Consider equally, both natural and cultural features in treatment and land-use decisions.

- Avoid land-use activities, permanent or temporary, which threaten or impair known or potential archaeological resources.

- Monitor and regulate use of the landscape to minimize immediate and long-term damage to cultural resources.

- Work with local counties and cities to determine whether a connection to the regional greenway is desirable through City of Republic and Ozark Greenways, Inc. An increase in bicycle traffic to or through the park may tax its carrying capacity.

- Consider carefully the appropriateness of any proposed recreational uses. For any proposed new use, consider the impact on natural and cultural resources, as well as traffic and parking. Avoid introducing any recreational uses that require extensive grading, the

[10] Samuel N. Stokes et al., *Saving America's Countryside; A Guide to Rural Conservation*, 2nd ed. (Baltimore: Johns Hopkins University Press, 1997).

introduction of non-native grasses, intensive maintenance, an increase in parking, or the addition of vertical features or lighting.

- Avoid permitting recreational uses that may endanger visitors, cultural resources, or sensitive ecosystem areas; that require extensive facility development; or that conflict with resource protection goals. Examples of incompatible activities include organized field sports, off-trail horseback riding or mountain biking, ATV use, and sport hunting.

- Prohibit ATVs, snowmobiles, and other motorized vehicles, as well as mountain bikes, from accessing backcountry areas and trails in the park. Prohibit geocaching.

- Monitor the potential impacts of equestrian usage including ground disturbance, modifications to trails, visitor-use conflicts, and the introduction of adventive vegetation.

- Avoid land-use activities, either permanent or temporary, that threaten or impair known or potential archeological resources.

- Limit, monitor, and control access to areas that are vulnerable to damage from human access or use.

New Design and Construction

- Design new construction taking into consideration the BMPs recommended in Chapter 7. In particular, design new construction using green building techniques, and incorporate technologies such as those described by LEED (Leadership in Energy and Environmental Design), a voluntary, consensus-based national standard for developing sustainable building.

- Undertake sufficient study and recordation of landscape features that require modification, repair, or replacement before work is performed to protect research and interpretive values.

- Locate any necessary new features supporting visitor services and administrative, operations, and maintenance functions in the Administration/Development Zone whenever possible.

- Design and situate new additions or alterations to the landscape in such a way that they do nothing to destroy historic materials, features, and spatial relationships that characterize the cultural landscape.

- Introduce new buildings and structures to facilitate access and interpretation while minimizing adverse impacts on the historic character and features of the landscape.

- Ensure that new construction is compatible with existing historic resources in materials, size, scale and proportion, and massing. Differentiate new work from existing resources.

- Design and situate new additions and alterations to the landscape in such a way that, if removed in the future, the essential form and integrity of the landscape would be unimpaired.

- Design new construction to have muted, neutral, earth-tone colors and materials that serve to make new facilities compatible with the historic and natural context.

- Ensure that the location, design, and construction of new facilities and systems is subordinate to the surviving cultural and natural landscape. New design and construction should be as visually unobtrusive as possible without sacrificing functionality.

- Avoid siting new buildings and structures in floodplains or in any of the primary viewshed areas.

Interpretation

- Consider a variety of means for interpreting significant historic features not associated with the Civil War Battle of Wilson's Creek. These features include the McElhaney Farm and County Road bridge, Gibson's Mill, the Missouri Pacific Railroad, and archeological evidence of prehistoric occupation and the Town of Wilson Creek. Interpretation of these features should be given a lower funding priority than battle—or mission—oriented interpretation.

- Provide an alternative means for interpretation, such as additional waysides or a Visitor Center exhibit, for those features located in areas that cannot be made universally accessible.

Prescribed Fire

- Ensure buildings and structures are not damaged by prescribed fire using the following guidelines:

  — Remove leaves and debris from roofs and gutters regularly to decrease the potential for fire hazards.

  — Store firewood and lumber a minimum of thirty feet from structures to decrease fuel near buildings.

  — Prune limbs on trees within thirty feet of a structure up twenty feet above the ground to remove ladder fuels. Likewise, prune limbs encroaching on power lines.

  — Establish a buffer zone of thirty feet, or one hundred feet on slopes, around building clusters. Buffers could include low, mown, grass or vegetable plots.

  — Maintain firebreaks and windbreaks around the perimeter of building clusters to slow or stop fires.

- Clear and/or backfire areas around buildings and structures and other important resources before prescribed fire activities take place.

- Cooperate with neighbors and local law enforcement and fire department officials to address concerns about and explain the park's prescribed fire plan. Keep these parties apprised of specific prescribed fire plans and schedules.

- Consult local law enforcement to determine relevant local ordinances to be followed when planning to use prescribed fire. For example, when prescribed fire occurs within 1,000 feet of a public roadway, some states require by law that smoke not impede visibility on the road.

- Maintain the existing firebreak that edges the entire park and ensure that fire does not travel beyond park boundaries.

- Establish an aggressive control plan that incorporates prescribed fire as necessary for invasive species.

- Address smoke management issues: monitor weather conditions, consider impacts, and take precautions when using prescribed fire near populated areas, highways, sensitive habitats, and other smoke-sensitive areas. Postpone prescribed fire activities when regional pollution levels are high or during temperature inversions.

- Plan prescribed fire activities for times of year when wildlife are not nesting. Consider and provide escape routes for wildlife in the prescribed fire area. For example, do not use the "ring burn" format, where fires are lit from the edges of a patch and burn to the center, as it can trap wildlife. This also creates a hotter flame than desirable in the center of the patch when the fires meet, which can cause damage to resources.

- Take into consideration the potential effects on archeological resources when developing a plan for using prescribed fire.

- Protect small-scale features and other fire-sensitive resources within prescribed fire zones.

- Consider alternatives in the design of interpretive materials, such as waysides, that can survive prescribed fire, be removed during prescribed fire use, or be otherwise protected from unwanted burning.

Management Zones and Treatment Recommendations

See figures 91 and 92, Overall Management Zones Map and Individual Management Zones maps at the end of this section

In addition to the general guidelines and recommendations conveyed above that relate to the park as a whole, recommendations are provided below that are specific to individual resources or resource types. These are arranged in accordance with a series of six management zones that have been devised to support the CLR. The zones group like resources for the purpose of providing more specific treatment approaches and strategies. The identification of management zones for the Wilson's Creek NB landscape takes into consideration the site's significance and integrity, as well as the management issues, goals, and objectives discussed in the GMP and provided to the CLR team by park personnel. The zones are also intended to be compatible with the prescription areas associated with the GMP's preferred alternative. The six zones utilized to convey treatment recommendations for the CLR include:

- 1861 Scene Rehabilitation Zone
- Administration and Development Zone
- Natural Resource Protection Zone
- Landscape Maintenance Zone
- Water Resource Protection Overlay Zone
- Archeological Resource Protection Overlay Zone

These are also based on the landscape character areas identified in Chapter 5 that subdivided the park landscape into a series of polygons characterized by similar land cover, former land uses, and resource types. The landscape character areas provide a way of organizing the site into sets of management needs. This information was compared against the management approaches taken to areas of the park as part of the GMP's preferred alternative. The direct relationship between the GMPs zones and CLR zones are described below within each management zone section.

Within the overall framework of rehabilitation, a resource-driven approach to landscape management is provided for each management zone; specific treatment recommendations are then provided to support the zone's management approach. In many cases alternatives for treatment are also provided that offer a range of options for the park and can be considered in conjunction with available levels of funding and maintenance capabilities.

1861 Scene Rehabilitation Zone

The 1861 Scene Rehabilitation Zone includes much of the Battlefield Landscape Enhancement area identified in the 2003 GMP, but also encompasses the Interpretive Focus management area (*see figure 92, Individual Management Zones maps*). It extends across the majority of the central portion of the park, and includes the key components of the battlefield landscape.

The goal of treatment in this area is to replicate as closely as possible the spatial organization and character of the battlefield as it appeared in 1861, primarily through the rehabilitation of vegetation. This zone will provide visitors with opportunities for contemplation, commemoration, and access to educational and interpretive features, with the 1861 Battle of Wilson's Creek as a primary focus.

Rehabilitation of vegetation will help to open expansive views through the center of the park, reestablishing view corridors important to understanding battle events. This area will also include an extensive trail system that provides pedestrian access to all of the important resources and sites associated with the battlefield. Interpretation will be enhanced through the provision of additional waysides and exhibits that convey the rich and significant history of the Wilson's Creek landscape. Interpretive as well as contemplative nodes will occupy key locations for visitor edification and comfort. Specific treatment recommendations are as follows:

Spatial Organization

- Restore the spatial organization of the 1861 landscape as closely as possible through rehabilitation of vegetation in the park through clearing, use of prescribed fire, and planting and seeding (see Vegetation below).

- Reestablish historic fence lines, or interpretive representations of fence patterns, using plants or small posts to delineate historic patterns of spatial organization. Reestablish fencelines in conjunction with field pattern restoration.

- Consider creative ways of depicting the spatial qualities of missing farmsteads. For example, mark missing house or outbuilding locations on the ground, plant orchard exhibits, and mow former farmyard areas in a distinctive fashion. Farmsteads to be depicted might include those owned by the Ray, C.B. Manley, Sharp, Edwards, Guinn, Gibson, Short, T.B. Manley, and/or Edgar families at the time of the 1861 battle. Before undertaking such measures, ensure that sufficient documentation is available to accurately depict their character and location. Conduct archeological surveys before undertaking ground-disturbing activities for installation of features that depict historic patterns of spatial organization, such as orchard trees and fencelines.

- Reestablish important visual connections to provide interpretation of sight lines integral to the battle events of August 10, 1861. Consider clearing and thinning existing woodland to establish critical views in the short term before vegetation management strategies have been completed. At a minimum, maintain the views from the East and West Battlefield Overlooks, between the Pulaski battery parking pull-off and Edwards Cabin, from Bloody Hill, and at the beginning of the Tour Road.

- Incorporate the majority of the parcels identified within the GMP as desirable additions to the park into this zone. Relocate the perimeter landscape maintenance zone to the edge of

any new parcels that are acquired in the future. Consider carefully the visual and physical—primarily circulation—connections between the existing park and any new parcels acquired.

Natural Systems and Features

- Evaluate the quarry site to determine if risks to visitor safety exist; if conditions are determined to be hazardous, limit visitor access.
- Protect and maintain contributing water features, including springs and Wilson's Creek.
- Locate, assess, and retain all springs and seeps within the park.
- Mitigate the potential increase in stormwater run-off associated with new trail development by establishing filter strips, vegetated swales, or other means along trail margins. Limit the use of systems that concentrate flow or increase direct flow into stream corridors. Attempt, wherever possible, to encourage infiltration of stormwater.

Vegetation

- Restore the savanna and woodland vegetation communities to approximate their 1861 landscape condition. This can be accomplished using the techniques described below.
  - — Locate old open-grown trees and rescue them by removing pole-sized trees and any other encroaching vegetation beneath their canopy.
  - — Select higher quality trees to save; thin others to open the canopy.
  - — Salvage timber where possible using sustainable harvesting practices as approved by the NPS.
  - — Control growth of adventive species such as multiflora rose (*Rosa multiflora*). Control methods for this plant suggested by The Nature Conservancy include: "The most effective means of eradication seem to be cutting followed by herbicide application. Glyphosate is commonly used and can be effectively applied in a 1% V/V solution, or 0.5% V/V solution if a surfactant is added, applied directly to the plants, cut branches, or stumps. Spring applications should show increasing control over the season with complete residual control the following spring. Repeat applications may be necessary in subsequent years to prevent recurrences."[11] See Chapter 7 for additional information regarding invasive species control measures.
- Begin, or continue, prescribed fire activities as fuel loads permit. In some instances, open savanna areas may be managed with fire alone.
- Establish a program to enhance prairie restoration areas. This program could include the activities and techniques described below:

[11] The Nature Conservancy website: http://tncweeds.ucdavis.edu/products.html.

— Seed regularly with wildflowers and other forbs. It is recommended that the program include regular enhancement seedings (even if relatively small in quantity) rather than an occasional mass enhancement seeding.

— Continue prescribed fire activities and attempt to burn annually or as frequently as fuel loads and/or park resources permit, following the park's Fire Management Plan.

— Remove, mechanically or by hand, shrubs that cannot be controlled by fire. Shrubs will become less of an issue with more frequent prescribed fire use. Coordinate herbicide applications as necessary to augment mechanical removal.

— Continue to develop approaches to control the growth of adventive species, particularly Johnson grass (*Sorghum halpense*) and Sericea lespedeza (*Lespedeza cuneata)*.

- Include the old fields in prairie restoration efforts as funding permits. In the short term continue to maintain old fields by haying, mowing, or with prescribed fire. Mechanically remove and/or hand-cut shrubs and invasive trees that become too large to manage with short term maintenance techniques. Coordinate herbicide applications as necessary. Mechanical clearing with equipment such as a brushog is suitable for areas dominated by shrubs and saplings that do not contain remnant native vegetation communities. Mechanical clearing equipment should only be utilized when the ground is sufficiently dry or frozen that the wheels will not disturb the soil.

- Maintain the historic Osage orange (*Maclura pomifera*) hedgerows along the Wire Road and the southern edge of Ray's cornfield.

- Retain and maintain other specific examples of cultural vegetation within the park including the line of sugar maples near the Sharp homestead site, and ornamental plantings at the Edgar and Manley cemeteries.

- Consider establishing fruit tree orchard exhibits at former homestead sites, including the Ray and Guinn properties, using late-nineteenth-century illustrations and maps to identify appropriate locations. See specific implementation guidelines provided in Chapter 7.

- Interpret crop fields associated with antebellum farms at Wilson's Creek. Establish small exhibit crop stands. Consider locations in close proximity to primary road and trail locations for these exhibits, particularly within the fencelines of the Ray and Sharp fields. (*see figure 90 for potential locations for crop field exhibits.*)

Circulation

- Rehabilitate the existing Tour Road by altering the surface when repaving is necessary. Replace the existing light-colored surface with a darker material, preferably a warm-colored aggregate paving material. Consider means for reestablishing natural hydrological processes that are currently impeded by the Tour Road corridor. Utilize pervious or porous pavement wherever possible, design the road grades to conform to the site's inherent hydrology, and establish filter strips and vegetated swales to promote infiltration of stormwater at the margins of the road corridor.

- Maintain and retain the existing character of the Wire Road trace, including its width, surface material of crushed brownstone, and irregular edges. Continue to maintain the margins of the trace free of vegetation for a few feet to either side. Avoid managing the trace with a manicured appearance.

- Continue to use the Wire Road as an equestrian and pedestrian trail. Monitor for any conflicts between these two visitor uses.

- Establish a new equestrian parking and staging area north of the Visitor Center parking area. Provide a connection between the new parking area and the Edgar Spur Trail to allow for access to the park's equestrian trails. Develop a new trail segment that re-routes equestrian use around the Ray cornfield. Extend the new trail segment to connect with the existing Manley Uplands Trail, and continue equestrian use of the Southwest Boundary Trail. Return via the Wire Road.

- Maintain the Wire Road and other historic road traces in good condition; repair drainage and erosion problems and uneven surfacing to ensure their suitability for pedestrian and equestrian use.

- Establish a series of pedestrian loop trails that provide access to the numerous historic features and resources of the Wilson's Creek NB landscape, particularly the sites of important events associated with the Battle of Wilson's Creek. The recommendations below include five loop trail segments which are described in detail. Implementation of these trails is discussed in Chapter 7 (*also see figure 90, Treatment Plan, for trail locations*).

- Ensure that new trail segments have as minimal an impact on the landscape as possible. The trails should be accessible only to pedestrians and persons with disabilities. The trail system should include a series of universally accessible interpreted segments tied to parking areas, and less formal back-country trail beyond, typically where the trails encounter steeper terrain. Trail margins should be maintained clear of woody vegetation to 2 to 3 feet to either side, allowing for a physically unimpeded but intimate trail character. Accessible trail segments should be surfaced with darkly-colored crushed stone, and have a width of 4 to 6 feet, with at a minimum bump-outs of 6 feet in width every 200 feet to allow two wheelchairs to pass. Back-country trail segments should be four feet in width and surfaced with hard-packed earth. Minimal grading should be utilized in trail establishment; every effort should be made to fit trails with the existing terrain. Back-country trails are intended to disturb the environment as little as possible. As such, extreme measures to ensure accessibility are not recommended.

- Engage an archeologist to conduct on-site investigations to determine any potential impact on cultural resources prior to construction of new trails.

- Incorporate historic road traces into new loop trail segments wherever possible:

  — If the road trace is highly discernible, consider selectively placing sections of the trail along the road trace. This will provide visitors with the experience of following the exact route of the historic circulation corridor.

  — If the road trace is missing or in poor condition, use historic maps and photographs to align the trail with the historic route. Prior to construction, engage an archeologist to conduct on-site investigations to determine any potential impact on cultural resources.

- Establish a new pedestrian trail (Trail 1) leading from the Tour Road pull-off 1. Replace the existing trail with a new trail that follows the historic road. Incorporate historic road alignments into the new trail, leading along the Gibson oatfield fenceline to the mill and house sites. Extend the trail across a bridge over Wilson's Creek and utilize a former road alignment as part of the trail route west of the creek. Establish spur routes between the field west of Gibson's Mill and the Short House site to the north, and the Bloody Hill trail to the south. These spurs are intended to support interpretation of Lyon's advance. Extend the main trail to the Tour Road. Follow the Tour Road back to pull-off 1 to complete the loop. Provide additional interpretive material along the trail.

- Design the bridge associated with Trail 1 to work with the hydrology of the Wilson's Creek corridor, particularly in the founding of the bridge abutments to avoid interfering with the stream's flow during storm events. Design the bridge to be as unobtrusive as possible and a product of its own time. Utilize simple materials, such as painted metal and wood, and muted colors that are compatible with the rural character of the historic landscape. Consider bridge designs that are low and do not draw the eye. Site the bridge to fit within existing grades as much as possible to avoid extensive grading to provide trail connections to the bridge decking.

- Continue to utilize the existing trails extending between Tour Road pull-off 2 and the Ray House and springhouse (Trail 2). Establish a new trail segment between the Ray springhouse and the Ray cornfield, providing interpretation regarding the battle events associated with the field.

- Establish a new trail (Trail 3) leading from Tour Road pull-off 3. Incorporate the existing Pulaski Arkansas Battery trail. Expand interpretation at the battery site to include exhibits nearby delineating features of the Guinn property, including its orchard. Incorporate a portion of the Wire Road into the trail route. Establish a new trail segment leading from the Wire Road to the C.B. Manley House site using a former road alignment for the route. Establish a new exhibit interpreting the C.B. Manley House precinct. Continue the trail south along the stream corridor, utilizing a former road alignment to site the trail. Cross the Tour Road and extend the trail along the eastern bank of Wilson's Creek to interpret Confederate encampments prior to the battle. The trail would then lead back to pull-off 3.

- Establish a new trail (Trail 4) leading from pull-off 4 along the Tour Road. Extend a spur trail to the site of Backoff's battery, via a bridge or ford over Wilson's Creek, and visually interpret Sigel's first position. Return across the creek, and extend the trail through the Sharp stubble field, where a Confederate encampment, troop movements associated with the 1st Arkansas, and Sigel's second position might be interpreted. Extend the trail to the park's western edge and link it with the Wire Road. Use mowing patterns to interpret a former road alignment that edged the fenceline of the Sharp crop fields. Use signage to denote the trail route and prevent the interpretive road trace from being utilized as a hiking or equestrian tail. Follow the Wire Road north, providing interpretation about the Osage orange hedgerow, the approach route taken by various Confederate battalions, and Sigel's final position. Follow the Tour Road back to pull-off 4, interpreting the Sharp farmstead and battle events and troop movements along the way.

- Signage would be necessary to prevent mown interpretive road traces from being utilized as hiking or equestrian trails. The trail would follow the Wire Road to the Tour Road, interpreting the approach route taken by various Confederate battalions, and Sigel's final position.

- Establish a new loop trail (Trail 5) in association with the existing Bloody Hill trail. Beginning at pull-off 7 along the Tour Road, follow the existing trail past the sinkhole to the Lyon Marker. Establish a new trail that skirts the glade community, revegetating the existing trail segment east of the Lyon Marker. Follow historic road alignments in extending the trail to the Wire Road, the Edwards Cabin, and Wilson's Creek. A network of other roads that also existed at the time of the battle would be interpreted through mowing patterns. Use signage to prevent mown interpretive road traces from being utilized as hiking or equestrian trails. Provide interpretation of additional missing roads that existed in 1861 through mowing patterns. Return to pull-off 7 by following the Tour Road; interpret troop movements and battle events for pedestrians along the way.

- Retain, maintain, and interpret the ford across Wilson's Creek along the Wire Road.

- Rehabilitate areas where existing trails are removed by revegetating the former trail prisms.

- Ensure that issues relating to erosion and negative impacts on surrounding native plant communities or the watershed are considered in the development of new trails.

Buildings and Structures

- Retain, maintain, and preserve the Ray House, Ray springhouse, Short springbox, McElhaney Farm complex, and County Road bridge.

- Conduct additional research and investigations to determine if the Short springbox was present at the time of the battle.

- Consider alternatives for the Edwards Cabin. Alternative 1 is recommended because it provides desirable interpretive opportunities without incurring additional cost beyond maintaining the existing structure. Alternative 2 is included as an alternate approach that is consistent with the Secretary of the Interior's Standards for Rehabilitation. Given the interpretive goals of the park, Alternative 1 may be considered preferable.

  Alternative 1

  — Retain the cabin *in situ*. Remove the plywood and metal sheathing and treat it as an exhibit that displays similar historic qualities to the cabin that was located on the site in 1861. Clearly indicate to visitors that the existing cabin is not an accurate representation of historic conditions.

  Alternative 2

  — Remove the cabin based on it having been relocated into the park from another property. Interpret the site of the missing Edwards Cabin through alternative means.

- Consider interpreting missing buildings and structures through various means, including foundation outlines, wayside exhibits, ghost structures, or waysides depicting an artist's rendering of the character of these former structures. Avoid reconstructing these features unless specific information about their appearance during the period of significance is acquired through documentary or archeological research.

Views

- Protect and preserve views from the Tour Road and overlooks.

- Clear weedy and woody vegetation to open up important views available in 1861, including the long views of the battlefield from the Ray House front porch; the view of the Sharp fields, Wire Road, and Wilson's Creek from Sigel's first position; and the views of the surrounding area from the crest of Bloody Hill. Consider conducting a seen-area analysis to determine where additional clearing might be beneficial to open up key views. The view toward Price's headquarters (Edwards Cabin) from the Pulaski battery parking area, and at the beginning of the Tour Road should also be considered for clearing.

- Protect views from Bloody Hill.

  — Undertake periodic maintenance to prevent vegetation from obscuring views.

  — Avoid placing any new construction or adding any new features within the Bloody Hill viewshed.

- Maintain sight lines through the Sharp and Ray fields. Undertake clearing activities to prohibit vegetation from obscuring views.

  — Plant warm season grasses for crops that were low or stubble at the time of the battle.

  — Plant corn, milo, or wheat where harvesting had not yet begun at the time of the battle.

  — Establish a view corridor after vegetation management practices have been put into place that extends from the beginning of the Tour Road into the battlefield landscape.

Small-scale Features

- Reestablish fence patterns that were present in 1861 at the Ray and Sharp farm fields, the Guinn property, Gibson oatfield and mill site, and the C.B. Manley property. Ensure, before establishing these fences, that sufficient documentation is available to replicate their appearance and locations in 1861. Conduct an archeological survey prior to ground-disturbing activities to install fence posts. Where insufficient documentation exists to accurately depict the missing fencelines, consider the following alternatives:

  Alternative 1

  — Consider installing only fence posts or low wooden posts rather than the complete structure. This alternative is preferable to Alternative 2 for its facility of implementation.

  Alternative 2

  — Consider planting vegetation that is visually distinct in the location of the historic fenceline where sufficient documentation is unavailable to support accurate reestablishment. Consider planting low shrubs or a contrasting herbaceous species to depict the location of the missing fenceline.

- Retain and maintain existing stone walls.

- Retain and maintain the Lyon Marker atop Bloody Hill.

- Retain and maintain the Edgar and Manley cemeteries, their perimeter fencing, and associated monuments and markers including the head- and footstones associated with the graves.

- Retain and maintain interpretive waysides that are consistent with the interpretive program for the park. Clean waysides regularly.

- Establish new waysides in the least intrusive manner possible to fulfill proposed new interpretive goals.

- Consider placing additional cannon at site's where artillery is known to have been utilized during the Battle of Wilson's Creek and primary trails or roads provide access to the location. Potential locations to consider include (*see figure 90 for locations*):

  — near the beginning of the Tour Road;

  — north of the Bloody Hill trail;

  — along the Bloody Hill trail leading toward the Edwards Cabin;

  — near Edwards Cabin;

  — near the C.B. Manley House site; and

  —in the Sharp stubblefield.

- Retain and maintain site furnishings that support visitor access and use of the site, including bicycle racks, hitching posts, benches, and trash receptacles. Replace site furnishings that are not in good condition. Provide additional site furnishings as necessary to support interpretive and contemplative goals.

Interpretation

- Establish a series of interpretive and commemorative nodes throughout the park. Interpretive nodes should be located in association with the Tour Road. Commemorative nodes should allow for reflective and contemplative activities, and include minimal interpretive materials, focus on views and memorials, and be located in quieter and more isolated areas.

- Consider interpreting missing land uses such as milling and other industries as well as agriculture throughout the park.

- Consider interpreting missing agricultural land uses such as crop fields at the Ray and Sharp properties. Establish limited crop exhibits in close proximity to primary road and trail corridors.

- Enhance interpretation of battle events that occurred within the Ray cornfield. Interpret troop movements through mowing within the Ray cornfield.

- Interpret a new orchard exhibit associated with the Ray House property.
- Interpret a new orchard exhibit associated with the Guinn property.
- Interpret a new exhibit of the Guinn House precinct and the fencing that encompassed the precinct as well as the adjacent orchard.
- Interpret an exhibit of the former C.B. Manley House precinct.
- Provide interpretive information about the missing Lyon cairn.
- Consider interpreting the Ray House as one of the earliest remaining settlement dwellings in the Springfield area.
- Consider interpreting the missing mill and house, oatfield, and adjacent road associated with the Gibson property.
    - — Plant the former Gibson cropfields in warm season grasses. Where 1861 crop field boundaries come within 100 feet of the edge of Wilson's Creek, utilize low-growing riparian plants to maintain a buffer in keeping with the Water Resources Protection Overlay Zone while at the same time maintaining a sense of the fields' 1861 spatial organization.
- Sharp farmstead site and crop fields:
    - — Interpret the Sharp farmstead site by establishing a new exhibit depicting the locations of the farmhouse and outbuildings.
    - — Plant the former Sharp cornfield in warm season grasses. Establish a limited crop exhibit in a portion of the field in close proximity to primary visitor road and/or trail corridors. Plant the Sharp stubble field in warm season grasses also, and consider mowing the field in late July to replicate the character of the cut cornstalks that were present at the time of the battle in August 1861.
    - — Interpret Sigel's second position along a trail through the field.
    - — Interpret the route of a former road that paralleled the Sharp field fencing to its west.
- Wire Road, including the ford crossing of Wilson's Creek:
    - — Interpret the role of the Wire Road in the battle.
    - — Consider interpreting the story of the Wire Road, including its development, role as a major route of communication and transportation, and part of the route of the Trail of Tears.

— Consider interpreting the telegraph line that followed the Wire Road in 1861 using physical elements such as poles along a segment of the road alignment.

- Guinn property:

  — Interpret the site of the Pulaski Arkansas battery, and the nearby former Guinn House that was utilized as a headquarters during the battle.

  — Incorporate a new orchard, fencing, and house precinct exhibit to depict the former Guinn property. See implementation guidelines for orchard establishment in Chapter 7.

Contemplative or Commemorative nodes

- Identify appropriate locations for quiet sitting areas where visitors can pause for contemplation and reflection. Such locations could include spots with panoramic views known to have played an important role in the battle and locations where major fighting occurred.

- Consider the following locations for establishing contemplative nodes:

  —Bloody Hill: Lyon Marker, cairn site, sinkhole;

  —Guinn House site or Pulaski battery site;

  —C.B. Manley House site;

  —Guibor's battery site; and

  —Short House site.

- Orient and locate contemplative nodes away from the Tour Road, and out of view of traffic.

- Provide seating in contemplative or commemorative areas to allow for quiet sitting and reflection.

- Thin vegetation in areas around contemplative nodes to allow for a comfortable sense of place, and designed views that are consistent with park-wide interpretation.

- Ensure that paths, trails, or parking areas providing access to commemorative and contemplative areas are universally accessible whenever possible.

Administration and Development Zone

This zone includes areas that are visually distinct from the interpretive core of the park, and includes buildings, structures, parking, and other features that support visitor services, park administration, and maintenance activities. This zone includes the "development" management areas identified in the GMP. The desired character and condition of this zone is to develop well-designed facilities that accommodate all current and anticipated needs using a palette of materials that is simple, contemporary, and a product of their own time, yet compatible with local and regional conventions. A goal of park development within this area is to conform with NPS standards, yet establish a unique graphic identity that can be expressed in all contemporary additions to the park. Specific treatment recommendations are as follows:

Spatial Organization

- Incorporate General Sweeny's Museum property into this zone if this property is acquired in the future. Consider carefully the physical relationship between the existing Visitor Center and the parcel, particularly visual connections and circulation routes.

Natural Systems and Features

- Control stormwater run-off from existing and future parking areas. Consider utilizing vegetated swales, planted filter strips, rain gardens, and other environmentally friendly means for reducing run-off and pollution and promoting stormwater infiltration on site rather than using a closed system of pipes that direct water to drainage corridors.

- Explore the option of using permeable materials for paving parking areas and all pedestrian circulation routes to minimize run-off.

- Minimize soil disturbance and grading when introducing new site developments such as parking, paths, and trails.

- Mitigate the impact of grading for new facilities by conducting archeological investigations prior to construction.

Vegetation

- Replace existing plantings associated with the Visitor Center that depend on irrigation, fertilizer, or pesticides.

- Maintain lawn areas with less frequent, higher mowings to allow for better infiltration.

- Plant only native species in this zone. Avoid and replace fescue turf to minimize the introduction of adventive plants and reduce mowing costs.

- Assess the condition of trees within this zone in consultation with a certified arborist. Determine whether they pose any threat or hazard to individuals or the buildings. Remove hazardous plants and those that may threaten the stability of buildings. Contact the local Agricultural Extension office or the NPS Olmsted Center for Landscape Preservation, located in Brookline, MA, for assistance in evaluating trees.

Circulation

- Retain the park's primary visitor parking area within the Development and Administrative Zone.
- Develop an expanded parking area to accommodate anticipated increases in visitation, and a new parking area suitable for equestrian use.
- Site the new equestrian parking area along the entrance road to the northeast of the Visitor Center on the relatively level knoll beyond the existing drainageway. Provide a connection to the Edgar Spur Trail for access to the park equestrian trails.
- Minimize the impermeable paved surface area of any parking and access routes. Whenever possible, utilize materials such as gravel, stabilized stone dust, stabilized turf, and permeable paving that reduce stormwater by allowing at least modest infiltration.
- Minimize cut and fill in the creation of a new equestrian parking area.
- Investigate the use of stabilized gravel for vehicular access surfaces.
- Consider, if asphalt or concrete is used on the site, utilizing a warm-brown colored aggregate.
- Mitigate the potential increase in stormwater run-off associated with parking area expansion using filter strips, grass swales, or other means that limit the use of closed systems (which concentrate flow and increase direct flow into stream corridors). Encourage infiltration of stormwater wherever possible.

Buildings and Structures

- Retain and continue to adaptively reuse the McElhaney Farm complex for administration. In general, adaptively reuse existing post-1861 buildings and structures before considering building new ones.
- Consider the possible use of the General Sweeny's Museum, if acquired, to fulfill museum and administrative functions as an alternative to building additional facilities within the park.
- Consider rehabilitating the Visitor Center by adding a green roof.

Views

- Screen views to new development that may be visually incompatible with the character of the rehabilitated battlefield landscape. Utilize woody vegetation that includes a mixture of deciduous and evergreen trees and shrubs to establish screen plantings.
- Add new features, such as the equestrian parking area, in such a way as to be as unobtrusive as possible. Consider views from the historic core area in their design and siting.
- Establish a screen planting between the Visitor Center/parking area and the beginning of the Tour Road to screen views as the young woodlands that currently screen views are rehabilitated to more closely approximate open savanna and prairie.

Small-scale Features

- Provide site furnishings such as benches, picnic tables, shade shelters, and trash receptacles in the designated picnic area. Use site furnishings that are compatible with the character of the park in design and materials. Ensure that the style of site furnishing is uniform throughout the park to avoid a piece-meal appearance.

- Keep signage minimal and unified in style. Most of the signage in this zone will be directional and regulatory in nature. Any interpretive waysides should follow the same guidelines as set forth in the 1861 Scene Rehabilitation zone section.

Landscape Maintenance Zone

This zone extends for 100 feet inward from the perimeter of the park (*see figure 92*). This zone will be treated for the most part like the 1861 Scene Rehabilitation Zone in that native plant communities will be rehabilitated as possible. It is recommended that vegetation be used in this zone as needed to screen views and sounds associated with adjacent properties that are managed or developed in ways that are inconsistent with the historic scene. Establish such screen plantings only where an open vegetative character, incompatible views, or traffic noise to impact the park. Current priority locations for screen plantings include between Farm Road 182 and the Tour Road in the area between McElhaney Branch and Wilson's Creek, and west of the Bloody Hill parking area south along the narrow strip of land to where it widens, just north of Guibor's Battery. The need for screening west of Bloody Hill identified by park personnel, however, is in direct conflict with the need for archeological investigations to learn more about the battle in this area. Screen plantings should therefore not be established to the west of Bloody Hill until archeological investigations have been conducted in this area. Specific treatment recommendations are as follows:

Spatial Organization

- Maintain patterns of spatial organization that are consistent with historic vegetation patterns wherever possible.

- Establish 100-foot-wide linear bands of woods along the park boundary wherever views of land beyond the boundary are considered to be incompatible with the historic scene.

- Consider, if adjacent lands are added to the park, the outer margins of the parcels acquired as part of the landscape maintenance zone and treat them as recommended above, and remove existing screen plantings between the former parkland and new land.

Natural Systems and Features

- Avoid disturbing sensitive natural resources in establishing screen plantings, including springs, seeps, rock outcroppings, caves, and communities associated with the Natural Resource Protection zone (see below).

- Avoid regrading in this area.

Vegetation

- Transition the old fields to prairie restorations as programming and funding permit. In the short term continue to maintain old fields by haying, mowing, or using prescribed fire. Mechanically remove and/or hand-cut shrubs and invasive trees that become too large to manage with short term maintenance techniques. Coordinate herbicide applications as necessary. Mechanical clearing with equipment such as a brushog is suitable for areas dominated by shrubs and saplings that do not contain remnant native vegetation communities. Mechanical clearing equipment should only be utilized when the ground is sufficiently dry or frozen that the wheels will not disturb the soil.

- Manage rehabilitated vegetation communities to approximate 1861 communities wherever possible.

- Establish screen plantings when necessary that are consistent with cultural conditions present in the existing plant communities. Conceive of screen plantings as part of a linear system that is comprised of bands of woody communities that evolve with the underlying soil, moisture, slope, and aspect.

- Establish screen plantings where necessary that are comprised of native woodland species. Incorporate existing woods into screen plantings as possible. Plant additional trees as necessary to effect desired screening. Include a mix of hardwoods and evergreens to ensure visual screening. Include native understory shrubs in the plantings to maintain screening properties at eye level.

- Eradicate adventive plants within the zone. Establish a monitoring program to identify invasive or adventive plants requiring removal in the future.

Views

- Retain and enhance existing woodland as a visual screen to limit current or likely future views of incompatible adjacent residential, commercial, industrial development, or other land use practices.

Archeological Resources

- Avoid establishing a wooded screen planting along the park's western boundary between Skegg's Branch and the northern edge of Bloody Hill where significant battle events are known to have occurred. Thin existing woodland vegetation in this area, and investigate the area archeologically for evidence of the battle. Consider interpreting this portion of the field of battle to the visitor.

Natural Resource Protection Zone

This zone encompasses sensitive natural resources including the limestone glades and the steep slopes west of Wilson's Creek. The priority in this zone is protection of natural resources through reestablishment of native vegetation communities, controlling erosion and deposition of sediment, limiting visitor access, and avoiding construction of new features or facilities.

Currently, the limestone glades are dominated by Eurasian brome grasses and not by the native perennial bunch grasses that would have historically grown on the site. If bunch grasses and sedges were reestablished in the deeper soil pockets across the glades and exposed to fire annually, the bunch grass physiognomy would enable condensation of night moisture to move from the air into the root zone and into the soil. A healthy functioning system such as this is more likely to withstand periods without rain. A weaker system dominated by Eurasian brome grasses may lead one to observe that the only moisture available during periods without rain is found within the dripline of the cedars.

As noted previously in the CLR, Eastern redcedars were scarce to absent in the glades prior to settlement, yet bladderpod was evidently well established on the glades. In fact, very few living things grow under cedars on glades today. It is when they are removed that the suppressed native remnant vegetation returns. It is quite clear that bladderpod's inhabitancy over the thousands of years prior to European-American settlement was in association with species other than Eastern redcedar. It is our recommendation that the glades be managed as systems in their aboriginal condition replete with all of the native associates and system integrity. This would be the preferred alternative for the curation of an individual species, such as the Missouri bladderpod. It should also be noted, however, that it is not an efficient use of resources to attempt to remove every cedar from the park landscape.

Specific treatment recommendations are as follows:

Spatial Organization

- Avoid removing plant species appropriate to the native vegetation communities present in this area, even if vegetation was not present in 1861. Areas under consideration include limestone glades, Manley woods, and steep slopes.

Natural Systems and Features

- Preserve and protect natural systems and features to the greatest degree possible in this zone.

- Restore glade plant communities to approximate their 1861 landscape condition. This can be accomplished using the techniques described below, which must be appropriately timed around the Missouri bladderpod's growing season (usually from June 15 to September 30).

    — Remove as many Eastern redcedars as funding and available personnel permit. If prescribed fire piles are used to dispose of cut material, they should be located in disturbed areas and not remnant or glade communities.

— Continue to experiment with techniques to control the growth of adventive species such as Eurasian annual brome grasses—*Bromus sterilis* and *Bromus tectorum*. There is no one known method to control the Eurasian annual bromes. The park should continue to experiment with different techniques and get input from others who are doing the same, such as the Nature Conservancy. Most all of the adventive species given as examples in the report can be found on their website and each has an "Element Stewardship Abstract" discussing management strategies. These techniques, along with records of the park's efforts at invasive species control, should be included in the updated Invasive Species Control Plan as discussed in Chapter 7.

— Seed native grasses such as little bluestem (*Schizachrium scoparium*) to provide fuel load. Grass seed should come from as many local seed sources as possible or be hand collected on site.

- Consider the management of glade communities in conjunction with savanna management. The treatment of surrounding savannas and prairies will enhance the richness and sustainability of the glade systems which are interspersed among them. Avoid making fire breaks at the edges of these plant communities, but instead allow fires to run from one community to the next. With regular and frequent prescribed fire used across the landscape, the glades themselves will determine their own fire frequency as fuel loads permit. It is not likely that every portion of every glade, particularly with many areas of rock exposed, will burn completely each year. This treatment is most effective if prescribed fires are set annually, keeping fuel loads low. Areas that do not burn in any given year should not be cleaned up.

- Limit visitor access to steep slopes as much as possible. Carefully design trails that extend across steeply sloped areas to include switchbacks and other means for traversing steep slopes in a sensitive manner that does not contribute to erosion.

- Conduct further study to determine whether caves at the park are used by the endangered gray bat. Gray bat colonies roost in specific kinds of caves and move seasonally, from deep, vertical, relatively warm caves where they hibernate in winter, to summer caves with specific temperature and roost conditions where they raise their young and feed on insects at nearby water sources. Human disturbance, especially in the summer maternity period, can result in the death of young and other serious damage to a colony. Other factors that have contributed to the decline in bat population are pesticide poisoning, loss of caves due to natural cave-ins, floods, or changes in water level due to impoundment of waterways; and a loss of food source due to pollution and siltation in streams and creeks where they feed on insects.[12]

  — Monitor gray bats and manage caves with their protection as a priority. Determine whether park caves provide summer or winter habitat for the bats.

  — Retain a minimum of 20 acres of forest around cave entrances when possible.

  — Direct trails away from caves.

[12] U.S. Fish and Wildlife Service website: http://endangered.fws.gov/i/a/saa4L.html.

— Prevent visitors from accessing caves where gray bats roost, especially during the summer months when they are raising young.

— Monitor and maintain water resource quality to ensure adequate riparian foraging for the bats.

— Educate visitors about the role of bats in the environment.

— Maintain water quality to ensure as pesticide- and pollution-free a food supply as possible.

— Maintain continuous forest canopy, 200 feet wide along streams; in the 20 acres around and above gray bat cave openings; and as travel corridors 200 feet wide from gray bat caves to riparian foraging areas. This canopy will provide protection from predators and a substrate for insect production.

— Avoid blocking or modifying cave entrances.

— Establish and maintain a forested zone at every cave entrance. This is particularly important to prevent erosion at sinkhole entrances.

— Avoid diverting all run-off away from a sinkhole, because its function usually is to convey water unless it has become isolated on a ridge. In Missouri, many sinkholes are mantled with soil, but they may still function as water collectors.

— Avoid alterations to the landscape over a cave, and avoid building infrastructure over caves, such as sewer lines, pipelines, and roads, especially if the cave contains streams and species of concern.

— Ensure when using prescribed fire that smoke does not enter caves, especially those occupied by endangered bats. For example, if prescribed fire is undertaken on a slope under certain meteorological conditions, a cold front may carry the smoke downward and into a cave, especially if it is a cold-air trap, which is dangerous for hibernating bats. Alternately, smoke could rise up the hill and into a cave that serves as a summer roost.

— Avoid loud noises and engine noises near sensitive bat caves. Some caves conduct sound a long distance into the passageways.

— Avoid constructing new trails near cave entrances.

— Gate a cave as a last resort to protect bats and other resources. Careful spacing of the gate's horizontal bars is critical to allow bats and other wildlife to move in and out freely, while keeping out humans. The widely accepted standards, specifications and design guidelines for cave gates can be found in the booklet *Bats and Mines* by Dan Taylor and Merlin Tuttle, published by Bat Conservation International.

Vegetation

- Make every effort to restore, protect, and maintain the limestone glade vegetation community.

- Protect and restore glade plant communities to approximate their 1861 landscape condition. See techniques for glade rehabilitation described above as part of the 1861 Scene Rehabilitation zone.

- Restore the savanna plant communities to approximate their 1861 landscape condition. See techniques for savanna rehabilitation described above as part of the 1861 Scene Rehabilitation zone.

Circulation

- Route major visitor circulation away from sensitive endangered species habitat areas including limestone glades and caves.

Buildings and Structures

- Avoid constructing buildings or structures in this management zone.

Small-scale Features

- Avoid adding small-scale features in this management zone aside from minimal signage to inform or educate visitors, and the fewest features necessary to discourage them from leaving the trails.

Water Resource Protection Overlay Zone

This is an overlay zone with a special set of prescriptions for managing sensitive water resources such as Wilson's Creek and its tributaries. The zone covers springs, seeps, perennial and important intermittent drainageways, as well as a corridor of land extending 100 feet from the banks on both sides of each perennial waterway in the park. This overlay zone takes priority over other land uses or management zones within its boundaries. Although the primary purpose of this zone is the protection of hydrologic resources, all attempts will be made to coordinate these efforts with the park's desire for scene rehabilitation to the August 10, 1861 period. Specific treatment recommendations are as follows:

- Preserve and protect waterways and hydrologic systems to the greatest degree possible in this zone.
- Restore the native landscapes within the park to maximize infiltration and stabilize the interior watershed.
- Begin to address larger drainage issues by modeling and analyzing the watershed areas that directly impact Wilson's Creek NB.
- Develop a Watershed Management Plan for the Wilson's Creek watershed that describes watershed conditions, problems, and detailed recommendations for rehabilitation and stabilization.
- Partner with local landowners and local, state, and federal agencies to begin to rehabilitate the watershed outside of park boundaries.
- Consider protection of known and potential archeological resources when addressing restoration of riparian areas.
- Establish riparian buffers or filter strips along water resources where soil erosion is an issue and/or where agricultural practices will be re-introduced near water resources.
- Establish riparian buffers that are, at a minimum, 50 feet wide, and extend between the bank-full water level and cropland.[13] For use as a wildlife habitat, the buffer should be increased to 100 feet in width.
- Employ vegetative filter strips if a lower visual character is desired.
- Allow for access to floodplain and bottomland areas only via designated trails.
- Retain, maintain, and interpret the ford across Wilson's Creek along the Wire Road.

[13] Agroforestry Notes, Jan. 1997.

Archeological Resource Protection Overlay Zone

Wilson's Creek NB is, in its entirety, an archeological site that requires the most careful treatment. Archeological resources abound in the park. The current battlefield archeological inventory indicates that the area from the Sharp crop field north to the transmission line corridor is one large archeological site with significant battle-related artifacts still in place. Inventory work conducted by the University of Arkansas indicates that there are historic and prehistoric archeological sites and features associated with virtually every landform in the park. Any action involving ground disturbance will require evaluation on a case-by-case basis to determine the potential impact on archeological resources. Although it is unlikely that every prescribed fire, mechanical vegetation removal or planting will require an archeological inventory, depending on where these occur, individual assessments may be necessary. This overlay zone covers specific sites throughout the park that constitute known or likely archeological resources. American Indian sites, the Gibson's Mill site, road traces, and the two post-1861 family cemeteries in the park are examples of features that would also fall under this overlay zone. Specific treatment recommendations are as follows:

- Protect archeological sites from disturbance, except for investigations necessary to address important research questions, and to consider proposed new additions such as trails and interpretive exhibits, and vegetation management treatments. The key to archeological site preservation is avoidance of subsurface disturbance. Thus, the best soil management strategy for archeological site preservation is that which involves the least disturbance. Maintaining grass is an excellent strategy for preserving subsurface archeological resources. Mown or unmown field grasses protect resources from erosion or other surface disturbance. Plowing can causes significant disturbance to archeological sites and areas proposed for plowing should first be evaluated for the potential impact to archeological resources. In some areas, additional metal detecting and/or geophysical investigations may be warranted, and formal archeological testing as mitigation for plowing recommended. Land maintained in forest is likely to preserve archeological integrity, except where a lack of plant cover allows for soil erosion. Groundcover generally protects resources, although growing tree roots will penetrate and disturb features. When trees are uprooted, significant disturbance is caused within and around the root ball. Removal of trees by means that uproot trees and plants or scrape the ground are destructive practices. Grinding stumps causes significant disturbance for several feet around the stump. Avoid grinding stumps in areas that may include subsurface resources. In these cases, cut trees to be removed flush with the ground.

- Consider carefully potential archeological resources when addressing restoration of riparian areas.

- Evaluate archeological sites to determine visitor safety and resource protection concerns.

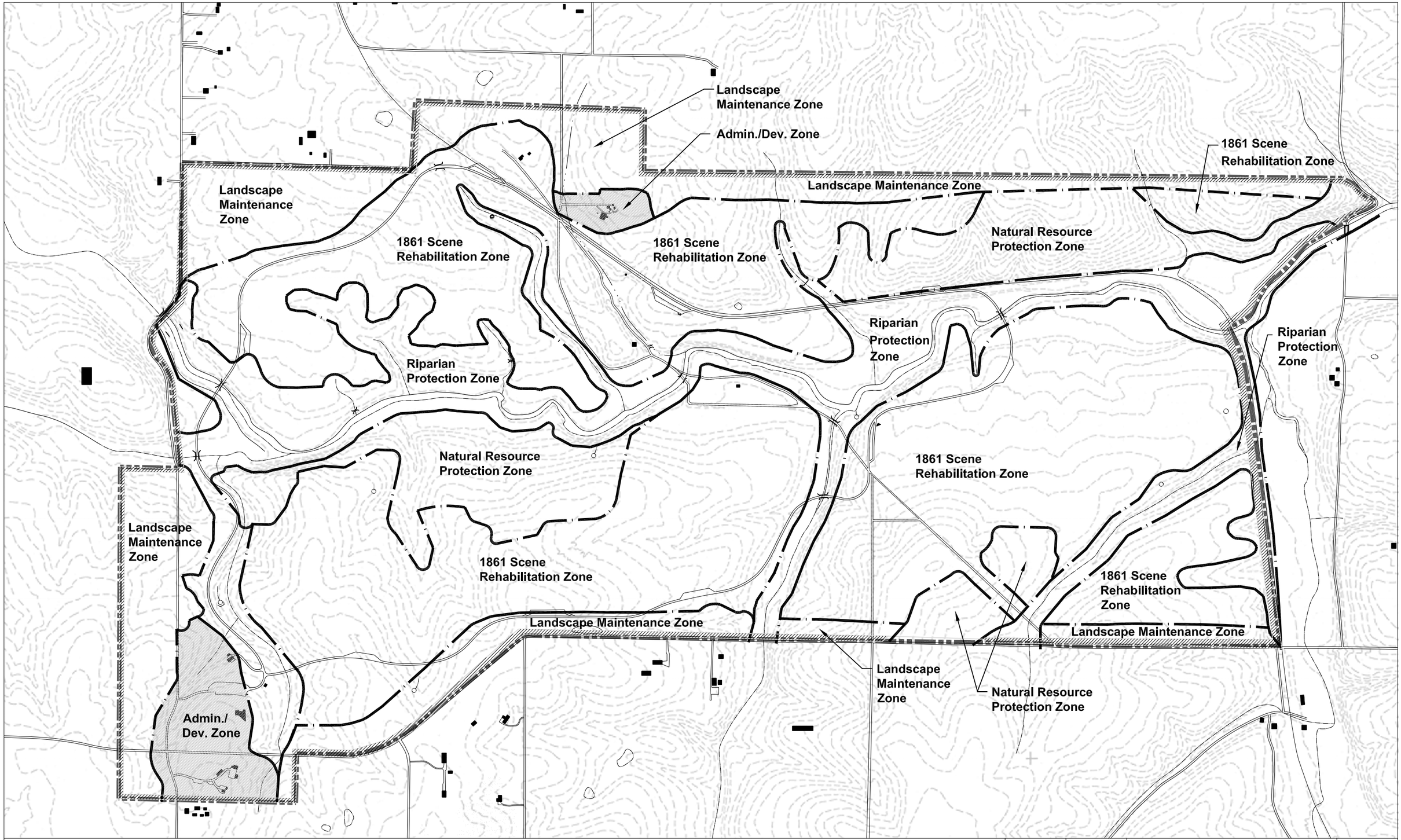
- Avoid establishing trails in areas associated with known sensitive archeological resources.

- Ensure that known and potential archeological resources are protected when restoring riparian areas.

- Monitor water resource margins for erosion and associated emerging archeological resources.

- Stabilize sites of known archeological resources affected by erosion by establishing and maintaining grass cover. Install erosion control measures such as textiles and grass using methods that do not further disturb subsurface resources. Avoid the use of material that is visually incompatible with the character of the area, such as riprap or other large stone.

- Prevent the buildup of large fuel loads (i.e. brush) which can generate excessive heat when conducting prescribed fire use, as this can damage archeological resources and imperil firefighters.



LEGEND

- PARK BOUNDARY
- MANAGEMENT ZONE
- PAVED ROAD
- GRAVEL ROAD
- EARTH/GRAVEL
- BRIDGE
- WATER
- BUILDING

not to scale

DESIGNED:	EAS
DRAWN BY:	GRL
TECH. REVIEW:	EAS
DATE:	09.28.04

SUB SHEET NO.

TITLE OF SHEET

MANAGEMENT ZONES MAP
WILSON'S CREEK
NATIONAL BATTLEFIELD

Figure 91. Overall Management Zones Map

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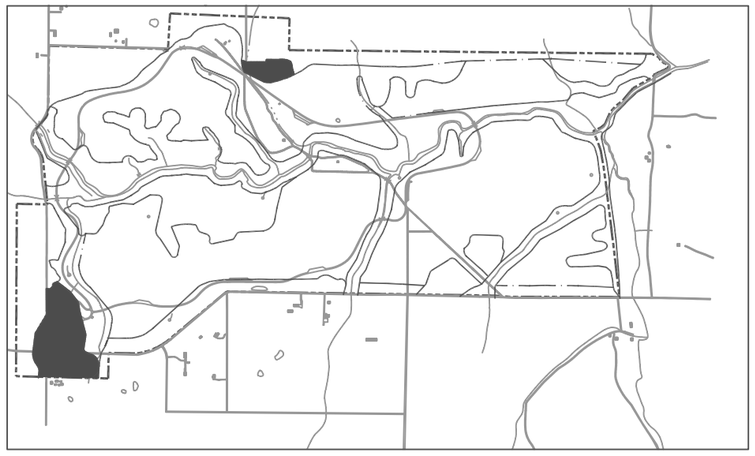
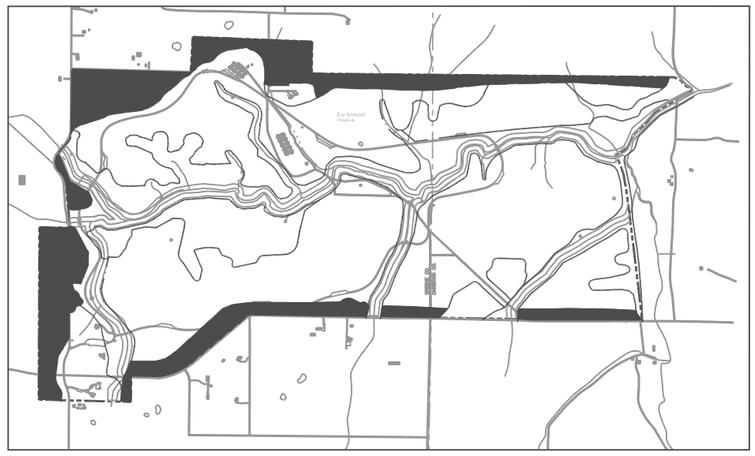
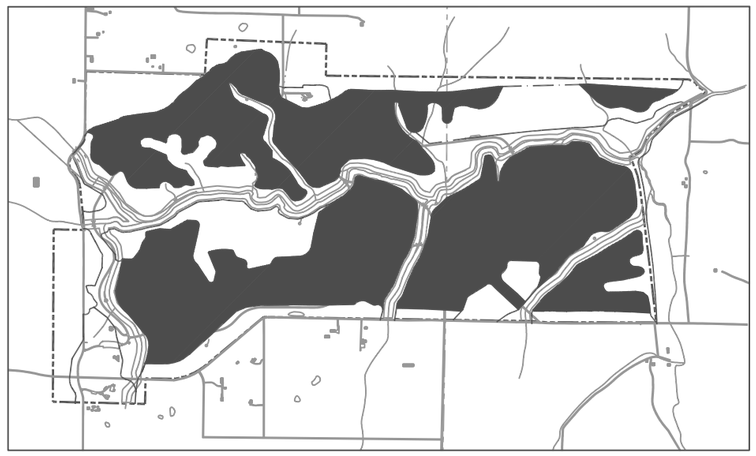


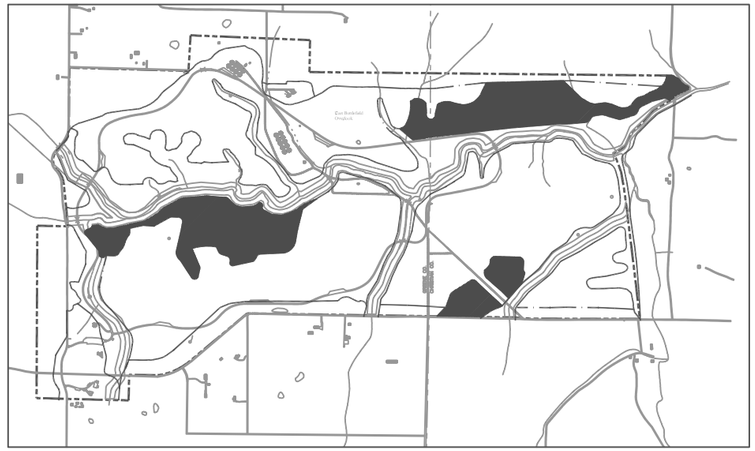
Administration and Development Zone.



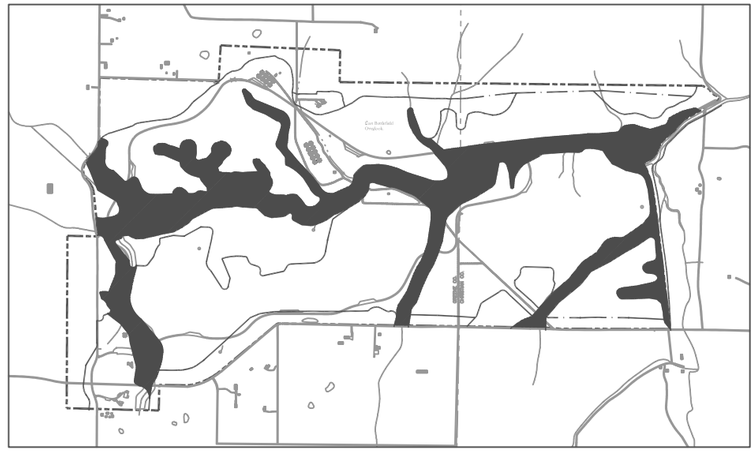
Landscape Maintenance Zone.



1861 Scene Restoration Zone.



Natural Resource Protection Zone.



Riparian Protection Zone.

Figure 92. Individual Management Zones maps

Trail 2:
0.50 miles

Proposed
Orchard
Exhibit

Proposed
Cannon

Existing
Equestrian
Trail

Protect and
Rehabilitate
Manley Woods

Trail 3: 1.38 miles

Proposed
Crop
Exhibit

Trail 1:
1.77 miles

Proposed
Orchard
Exhibit

Trail 4:
1.95 miles

Screen
Planting
(typ.)

Proposed
Cannon

Proposed
Crop
Exhibit

Proposed
Cannon

Rehabilitate
Glades
(typ.)

Proposed
Cannon

Proposed
Equestrian
Trail

Trail 5:
1.86 miles

Proposed
Cannon

Spur

Contemplative
Node (typ.)

Clear Views
(typ.)

Relocate
Electrical
Lines Underground

Proposed
Equestrian
Staging/
Parking Area

General Notes:
1. Rehabilitate young woods as open timber grasslands.
2. Rehabilitate prairie and savanna restoration areas to enhance biodiversity.

PARK BOUNDARY
POTENTIAL PARK ADDITIONS
COUNTYLINE
POWERLINE
WAYSIDE
INTERPRETIVE EXHIBIT

PAVED ROAD
GRAVEL ROAD
EARTH/GRAVEL
PROP. PEDESTRIAN TRAIL
PROP. EQUESTRIAN TRAIL
PROP. MOW LINE

SIGN
BRIDGE
CULVERT
WATER
CANNON
BUILDING

PRAIRIE/SAVANNA RESTOR. AREA
GLADES
MANLEY WOODS
YOUNG WOODS
CULTURAL VEGETATION
WATER RES. PROTECTION AREA

POTENTIAL CROP EXHIBIT AREA
SCREEN PLANTING
CLEARED VIEW
CONTEMPLATIVE NODE

not to scale

DESIGNED:	EAS
DRAWN BY:	GRL,ADF
TECH. REVIEW:	EAS
DATE:	09.28.04

SUB SHEET NO.

TITLE OF SHEET
TREATMENT PLAN

WILSON'S CREEK
NATIONAL BATTLEFIELD
Figure 90. Treatment Plan

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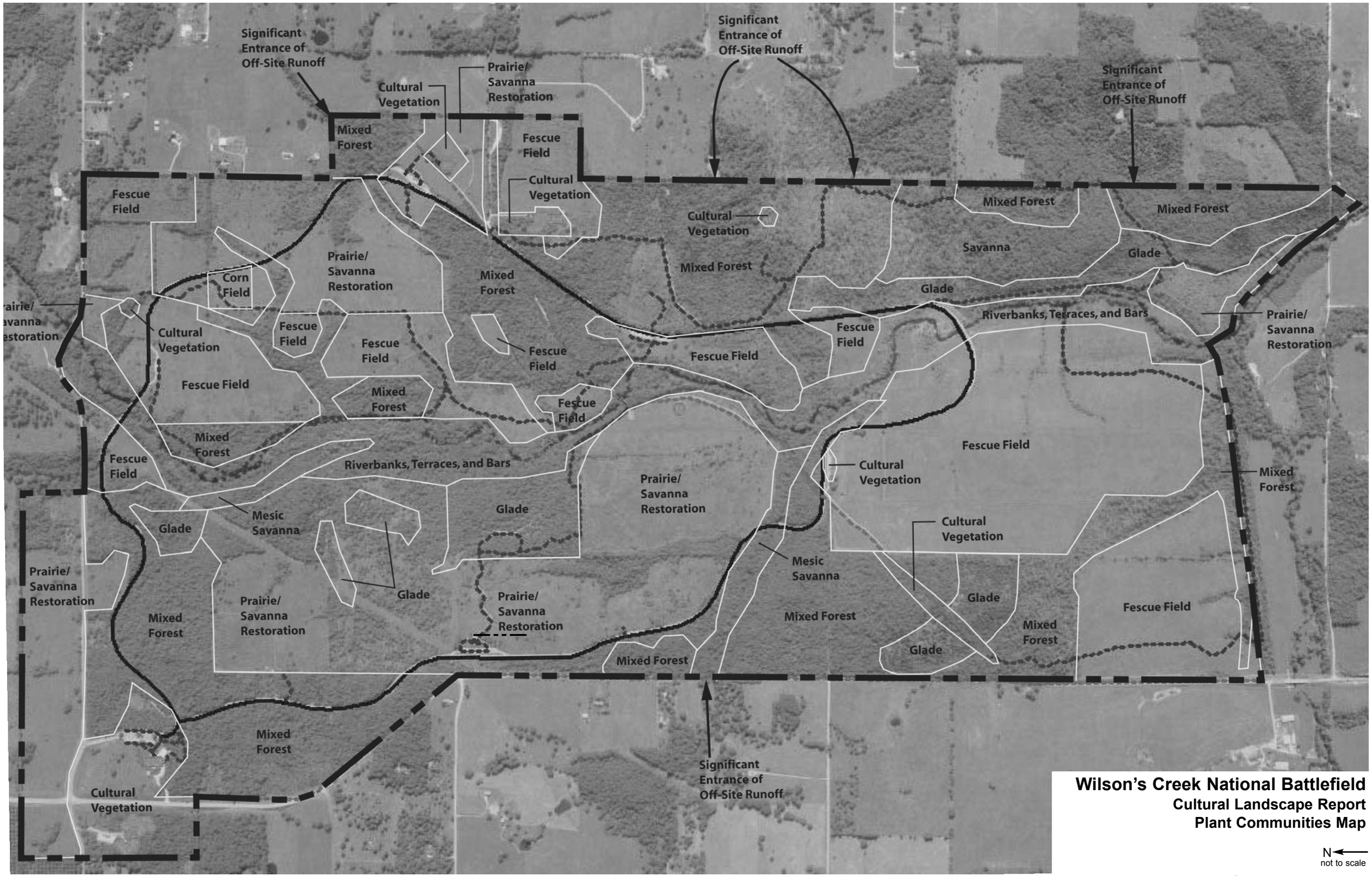
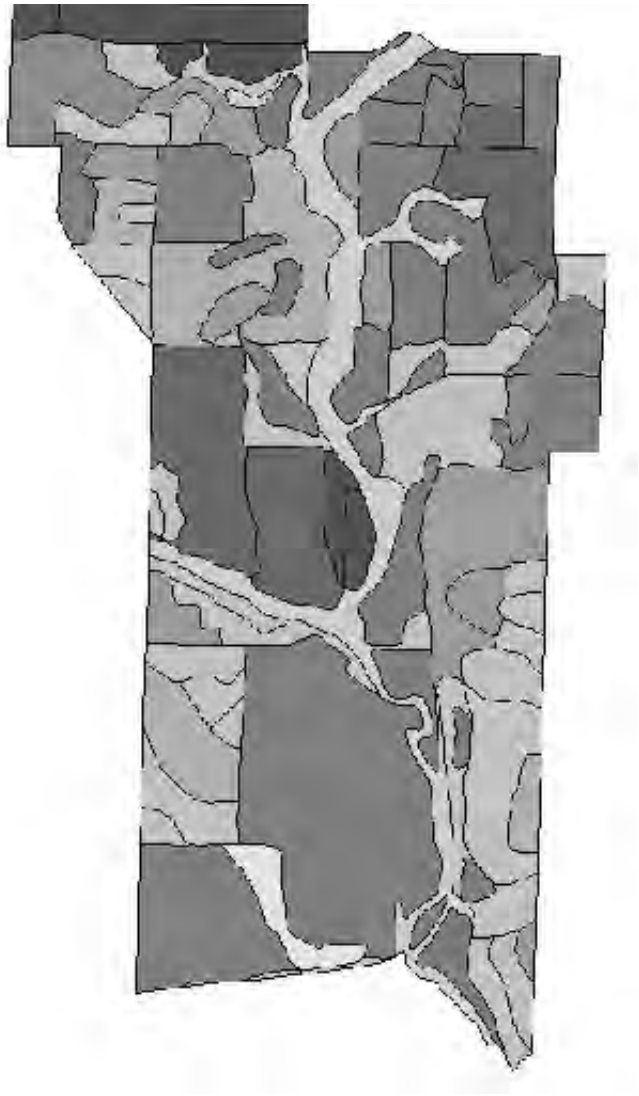


Wilson's Creek National Battlefield
Cultural Landscape Report
Plant Communities Map

N
not to scale

Figure 93. Plant Communities Map.



Chapter Seven • Implementation Guidelines

CHAPTER SEVEN

IMPLEMENTATION GUIDELINES

Introduction

This chapter describes the means for implementing the recommendations included in the previous chapter. Implementation of the Wilson's Creek National Battlefield (NB) treatment plan has been divided into a series of sixteen projects, described in detail below. The descriptions of the projects are organized in accordance with the format of the National Park Service's (NPS) Project Management Information System (PMIS) forms that are utilized to request funding. These projects are intended to respond to the guidance provided in the park's GMP and other planning documents, as well as to life safety considerations and visitor accessibility and interpretation needs. All projects are subject to review under the federal Section 106 compliance.

Each project is presented individually with a summary description; the considerations or justifications associated with its inclusion in the treatment plan; identification of the project's location; and specific implementation recommendations. Most of the projects listed below depend on the completion of one or more park- or area-wide studies or plans, some of which are currently underway. Park-wide studies mentioned as necessary for implementation in numerous projects that follow include a Long-Range Interpretive Plan, vegetation management plan, prescribed burn plan, invasive plant management plan, and watershed study for Wilson's Creek. The breakdown of tasks for each project does not include project management, compliance-related reviews, and other management elements typically undertaken by NPS personnel as part of the planning, design, and construction phases of a project.

Identification of Treatment Projects

The sixteen treatment projects explored in this chapter are as follows:

1. Restore watershed
2. Establish riparian buffers along stream corridors
3. Rehabilitate glade communities
4. Rehabilitate savanna communities
5. Establish warm season grass fields within historic crop field areas
6. Update invasive species control plan
7. Establish filter strips in association with crop exhibits and parking areas
8. Reestablish critical views associated with the Battle of Wilson's Creek

9. Establish new trails to provide access to interpreted sites and resources
10. Interpret missing 1861 farmsteads
11. Establish crop field exhibits in limited locations
12. Establish orchard exhibits in limited locations
13. Provide new equestrian parking complex at the Visitor Center
14. Establish specific equestrian trail and access routes
15. Develop design guidelines for contemporary park features
16. Establish a comprehensive landscape stewardship and monitoring program

Implementation Guidelines by Treatment Project

1. Restore watershed

Introduction

One of the critical factors that affects the sustainability of Wilson's Creek NB is the way in which rainwater is handled both off and on the site. Clearly, the NPS has the autonomy to remediate rainwater that falls on the site. There is very little that one can do that can remediate or ameliorate the impacts of stormwater that flows from off-site into or through the park by way of Wilson's Creek, or through massive erosion ditches caused by local agricultural run-off.

Most of the regional land uses that contribute to the degradation of the park are present on-site as well; these include paved roads and associated ditches, parking lots, lawns, buildings, agricultural land, and even native landscapes. Consequently, the NPS has the opportunity to address engineering, architectural, and landscape architectural solutions to these issues. To do so in a visible and interpreted way would present local examples to the community within the watershed, which may broaden understanding and encourage the leadership toward sustainable land use choices on a local level. In the long run, such outreach may be the surest way to preserve, protect, and enhance the park's critical cultural and natural resources.

It is recommended that a workshop be arranged to explore every aspect of land use at the park and determine the aggregate array of integrated "Best Management Practices" (BMPs) that could be designed, phased in, and interpreted. Local watershed partners, adjacent landowners, city officials, park visitors, and NPS staff would be encouraged to attend and participate in the workshop.

Sample Stormwater Best Management Practices

The following are descriptions of potential stormwater BMPs. The descriptions provide more detailed information on each of the individual design and planning components of these techniques, including their applicability, effectiveness and general benefits.

Stormwater BMPs are stormwater management measures used to minimize on-site and off-site hydrologic and water quality impacts due to run-off, by attempting to reestablish natural hydrologic processes and incorporate them into the built environment. These measures can be designed and implemented in new developments as well as retrofitted into existing development in cost-efficient ways. Stormwater BMPs have the capability to significantly improve the quality of stormwater run-off as well as quality of life. The practices discussed here include:

- green roofs (*see Appendix G*)
- parking area design (*see Appendix G*)
- bioswales (*see Appendix G*)
- filter strips/level spreaders (*see Appendix G*)
- naturalized detention (*see Appendix G*)

— porous pavement (*see Appendix G*)

— rain barrels/cisterns (*see Appendix G*)

— rain gardens (*see Appendix G*)

— vegetated swales (*see Appendix G*)

— use of native plants for landscaping (*see Appendix G*)

Native landscaping, as a BMP, is its own category due to the importance of vegetation in biodiversity, aesthetics, habitat, cooling of ambient air, and stormwater management. Native landscapes benefit stormwater management through the infiltration and cleansing of run-off.

Each BMP is discussed individually in Appendix G, beginning with its definition, associated benefits, and potential design considerations. A more detailed description of these specific discussion categories follows:

Definition—a brief description of the BMP relative to stormwater management.

Benefits—other positive effects that the individual or system of practices perform. Benefits can be specific to stormwater management or be more general to various functions and values for the quality of life.

Design considerations—design recommendations and suggestions that should be considered when implementing the specific BMP. Drawings are not illustrated for construction, but are a general guide for the components of the practice.

Recommendations

- Consider green building principles (LEED) for the visitor center, in particular a green roof system. *(see Appendix G, green roof detail.)*

- Consider retrofitting the visitor center parking and other parking areas, as well as the Tour Road to manage stormwater in a more sustainable manner through the use of bioswales and other BMP techniques. *(see Appendix G.*

Streambank stabilization techniques

Introduction

The banks along Wilson's Creek and its tributaries: Skegg's Branch, McElhaney Branch, Manley Branch, and Short's Branch are experiencing two distinct types of erosion. One type of erosion is caused by flowing water; the other is caused by surface run-off.

Streambank erosion caused by flowing water occurs when high velocity flow erodes the toe of the slope. Once significant material is lost from the toe, the upper bank becomes overly-steep or loses its foundation and slope failure occurs. The upper banks are generally protected from direct erosion induced by flowing water (due to significant tree cover on the streambank). However, contrary to conventional wisdom, a heavily wooded streambank is generally not sufficient erosion protection.

While tree roots provide some level of protection of bank soils, the coarseness of the roots allows flow at the toe of the slope to erode soil from around them. Once the erosion progresses to a sufficient degree, the tree eventually topples and causes catastrophic soil loss as the root fan dislodges a substantial portion of the bank.

Deep-rooted herbaceous vegetation has very fine roots that bind the soil together. Further, the roots are continuously regenerated, increasing stability over time. While no purely vegetative method is likely to completely stop erosion under the conditions experienced along most of Wilson's Creek and its tributaries, with further hydrologic analysis, a healthy and diverse layering of deep-rooted grasses, sedges, and forbs may considerably slow the erosion and help hold the slopes.

The other type of erosion observed on the banks of the stream is sheet erosion, which is caused by surface run-off down the slope. In some areas, the source of run-off is adjacent paved surfaces (such as parking lot, tour road, etc.) that directly drain to the banks. In other areas, the slopes are sufficiently long enough that run-off from the slope itself appears to cause erosion. This type of erosion is common on the densely wooded slopes visible throughout the park that have no vegetative cover to protect the soil surface from sheet and rill erosion. With sufficient thinning of the tree canopy and understory, deep-rooted herbaceous cover can be established. The herbaceous cover protects the soil surface from erosion and prevents or slows down run-off from the slope itself.

Streambank erosion treatments along Wilson's Creek and its tributaries are broken into two groups – edge treatments and slope treatments. Most reaches of the stream will require both edge and slope treatments.

Streambank Treatments

Streambank treatments are intended to address streambank erosion at the toe of the slope caused by flowing water and wave action. The streambank treatments generally address the normal

water line up to approximately 2 feet. The demarcation between streambank and slope treatments will vary depending on the amount of water level fluctuation and wave height.

Slope Treatments

Slope treatments are intended to address the slope approximately 2 feet above the normal water level. In most cases, the slope treatment must be combined with toe protection at the water's edge.

Streambank Treatments

1. Streambank Treatment - Stacked Flat Rock
Stacked flat rock such as limestone, granite, or broken concrete slabs provides a relatively aesthetic and functional alternative for shoreline treatment. The reestablished slope should be seeded, covered with an erosion control blanket, and planted with native plugs as necessary. If stacked flat rock treatment is installed with stable, overhanging slabs adjacent and within the water, this may provide cover for some macroinvertebrate species. This may also provide a resting area for waterfowl and possibly other species. This type of treatment will not create a habitat per se, but it may provide resting and cover opportunities for some fauna species.

Advantages:

- Provides significant toe protection from flow and wave energy.
- Can be mortared or stacked (gravity).
- Visually appealing along the stream.
- Provides access to the water's edge.
- Stone will absorb and resist wave action.
- Provides some level of macroinvertebrate habitat, which can be important in Wilson's Creek and its tributaries where the majority of the bottom is very silty and devoid of macroinvertebrate habitat.
- Opportunity for use of recycled material.

Disadvantages:

- Tends to transmit flow and reflect wave energy.
- Subject to failure where there is potential movement in the streambed.
- Can be expensive, depending on height of wall and material used. Cost may be relatively low in areas where an existing wall can be rebuilt using material still present.
- There may be significant wetland and floodway permitting issues related to the use of retaining wall streambank treatments.
- A potential source of failure of this treatment is tree roots dislodging individual slabs.

Maintenance:

- Unlike many retaining walls, stacked stone is generally quite repairable if not mortared.
- Provided that a proper foundation is constructed and trees are prevented from growing too close to the wall, little maintenance should be required.

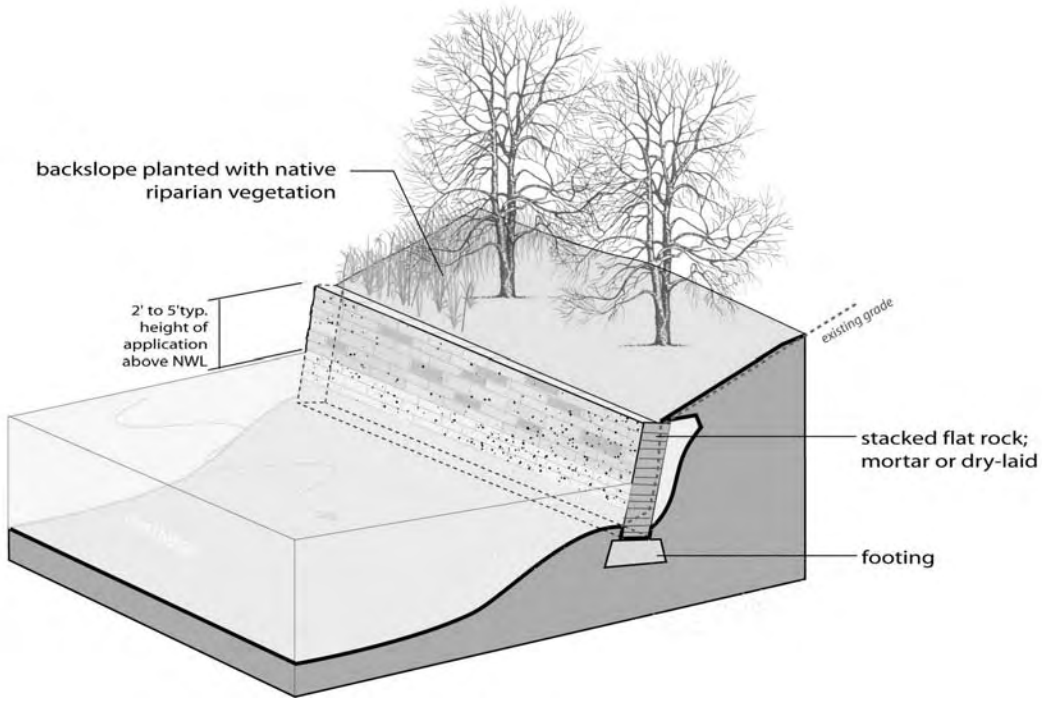


Figure 94. Stacked flat rock diagram.

2. Streambank Treatment - Stone Toe Protection

Stone or cobble trenched and embedded into the toe of the streambank serves as a foundation for the slope above, as well as armor against erosion. The interstitial spaces between stones can be planted with emergent vegetation to soften the appearance and increase water quality and habitat benefits. The height of the stone should be sufficient to address wave energy where this is a significant concern. Once well vegetated and weathered, the stone is not readily visible and has a relatively natural appearance. Once the slope is reestablished, it should be seeded, covered with an erosion control blanket, and planted with plugs as necessary. Variations on the stone toe protection concept are A-jacks, or other similar prefabricated concrete structures. A-jacks are approximately 2 feet square concrete structures with a similar appearance to a toy jack. They are nested together to form a flexible foundation to provide toe protection. Due to their shape and the interlocking of the individual jacks, A-jacks are extremely stable. This method can offer some cover habitat for macroinvertebrate and small fry fish. This can be important where the majority of the bottom is silty and devoid of macroinvertebrate habitat. Although the emergent zone is narrow, this may provide some foraging habitat opportunity for macroinvertebrate, small fish, and wading birds.

Advantages:

- Very effective method of toe stabilization where wave heights/water do not exceed height of stone. A-jacks are very stable and can resist high stream velocities and continuous wave action.
- Can be placed with minimal disturbance to the upper slope but must be trenched into the bed of the stream to provide slope stability and improve longevity.
- Gaps between larger stone can be interplanted with vegetation.
- Provides a flexible structure that can withstand modest movement without failure.
- A-jacks are quite resistant to vandalism.
- Provides some cover habitat for macroinvertebrate and small fry fish.
- Cost effective method where hard toe stabilization is required.

Disadvantages:

- A-jacks are more expensive than stone and their installation is relatively specialized.
- Stone may be subject to vandalism. (Throwing of stones into the creek).
- Stone may be considered unaesthetic in some locations, especially if large stone is required or the stone is not interplanted with native vegetation. Aesthetic qualities of A-jacks may be more of a concern than for stone.
- Although stone and A-jack allow for a modest emergent edge, the emergent zone is quite narrow.

Maintenance:

- Little maintenance needed other than periodic inspection and repair if rocks have been moved. Repairs are relatively easy.
- A-jacks are less likely to require periodic repairs but it is difficult to replace individual jacks due to the interlocking nature.

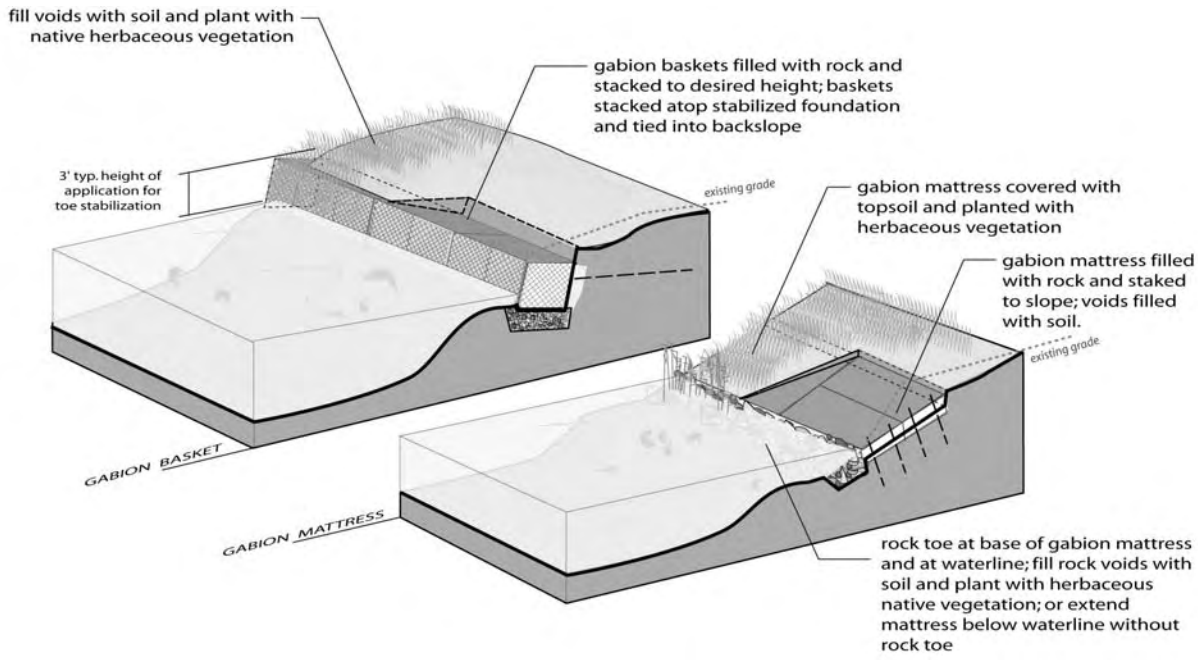


Figure 95. Stone toe protection.

3. Streambank Treatment - Gabion Basket or Mattress

Gabions are rectangular baskets or mattresses made from galvanized wire mesh that are filled with small to medium size stones. Gabions are tied together and placed at the bed/bank interface for immediate streambank stabilization. Soil can be used to fill the void space and planted with vegetation to soften their appearance and improve water quality and habitat. Once the slope is reestablished, it should be seeded, covered with an erosion control blanket, and planted with native plugs as necessary.

If gabion baskets or mattresses are planted with native herbaceous vegetation, this treatment will provide similar habitats as the stone toe protection treatment. There would be potential cover habitat for smaller organisms, and some foraging opportunities for macroinvertebrate and small fish.

Advantages:

- Allows use of smaller stone than stone toe protection method for a given level of erosive pressure. Cost effective structural solution if required rock size is greater than what is locally available.
- Can provide a significant foundation for the upper slope.
- Because the baskets form a vertical wall, gabions can be used to fill a larger vertical cut.
- Gabions are conducive to vegetative growth if they are filled with soil.
- Gabion mattresses can be tailored to irregular shapes, e.g. transitions from one type of treatment to another, around drains, and other structural features.
- Provides some cover habitat for macroinvertebrate and small fry fish, especially when combined with native vegetation.
- Provides a semi-flexible structure that can withstand modest movement without failure.

Disadvantages:

- Tends to transmit flow and reflect wave energy (although not as severely as smoother walls such as sheetpile).
- Expensive to install and replace.
- Subject to vandalism.
- Wire mesh subject to sediment, ice abrasion and extremes in water pH that may lead to corrosion.
- Slope stability protection can be lost when damaged.
- Aesthetically unpleasing when not vegetated.
- Requires a stable foundation.
- Care must be taken during filling and complete lacing of the mattress components, which can be costly.
- Less flexible than stone toe.
- There may be significant wetland and floodway permitting issues related to use of gabion mattress treatment.

Maintenance:

- Wire mesh may need to be replaced.
- Periodic inspection to see if gabions have subsided.

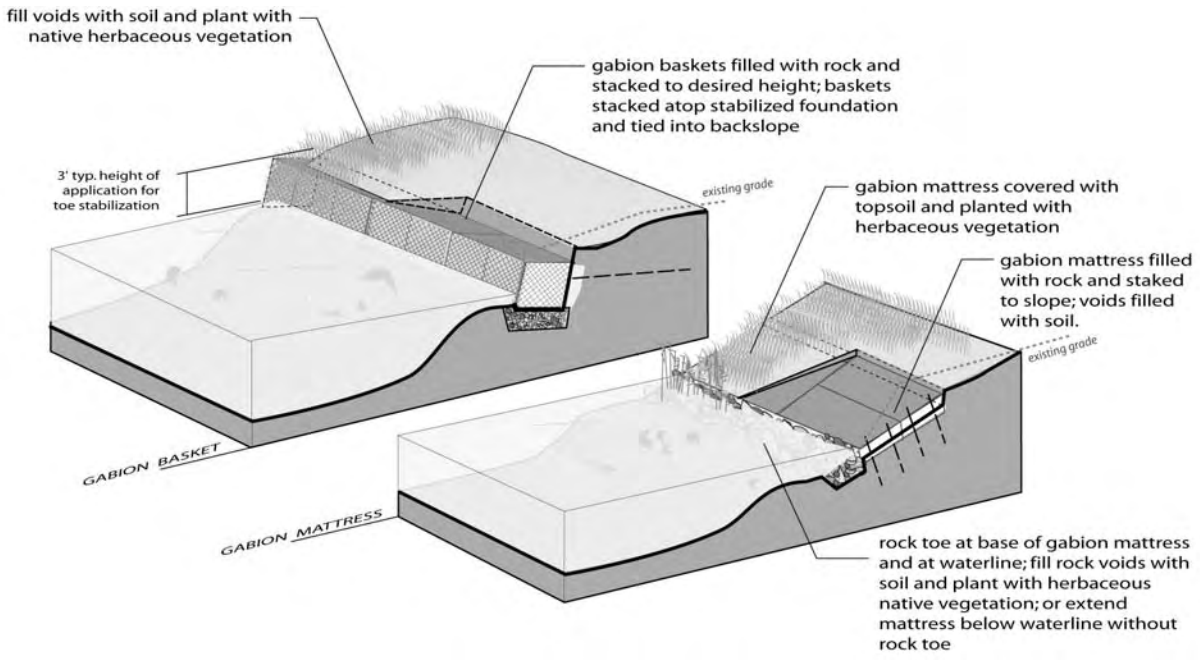


Figure 96. Gabions.

4. Stream Edge Treatment - Sheetpile (low wall)

Often made from steel, sheetpile is an effective toe protection method, especially in deep-water situations. When used for stream edge protection, only a low sheetpile wall is necessary to provide a foundation for the upper slope and protect against scouring. It can also be placed below water level so that it is not visually intrusive, but the protection from scour may be lost. When capped, it offers a seating and walking surface at the water's edge. Once the slope is stabilized, it should be seeded, covered with an erosion control blanket, and planted with native plugs as necessary.

Advantages:

- Properly installed sheetpile is one of the most effective and long-term stabilization treatments.
- Opportunity to provide public access to the water's edge when capped at an adequate width for pedestrians.
- Can be used for deep water application.
- Can be used above or below normal water level.
- When height is limited and there is a vegetated slope above, sheetpile can be nearly invisible from the land side of the wall.

Disadvantages:

- Most expensive stream edge treatment method.
- Difficult and expensive to repair.
- Visually sterile.
- Provides virtually no aquatic habitat for fish and other wildlife.
- Stone apron is needed to prevent scour and undermining, particularly where there is significant wave energy.
- Transmits or reflects flow and wave energy downstream.
- There may be significant wetland and floodway permitting issues related to the use of sheetpile.

Maintenance:

- Very little maintenance is required.
- Periodic inspection to evaluate and address scouring.

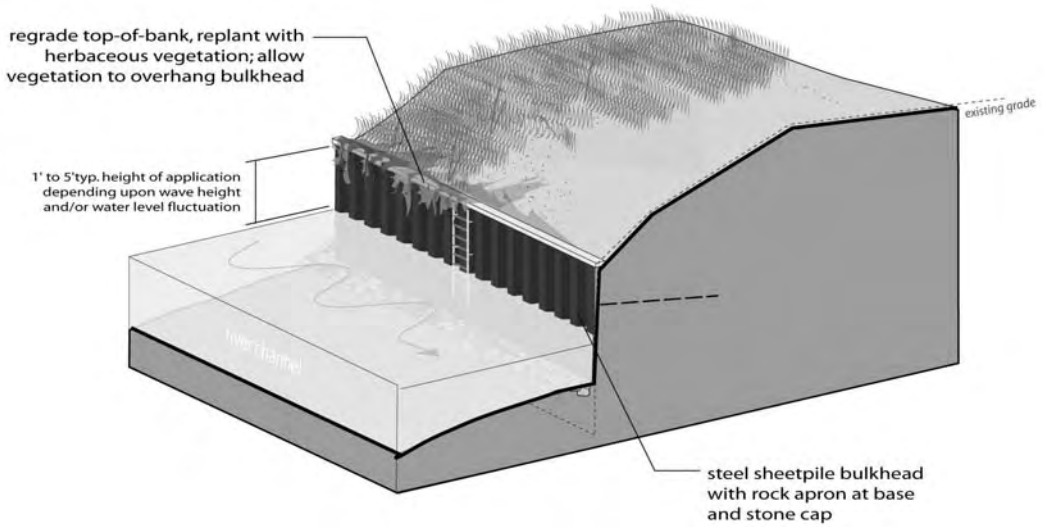


Figure 97. Sheetpile.

5. Streambank Treatment - Fiber Roll

A fiber roll is a cylinder of nonwoven fibers made from compacted coconut husk fiber, and wrapped within a coir woven mesh rope or coconut fiber mesh. Fiber rolls are available in varying diameters and lengths. Installation of the fiber rolls occurs in a linear fashion along the toe of eroding streambanks to prevent erosive flows or wave energy from directly contacting the toe of the bank. The rolls are staked into place and planted with appropriate native wetland plants. The long-term stabilization is dependent upon extensive establishment of the vegetation as the fiber roll slowly biodegrades. Site conditions that need to be considered include: hydrologic regime – one that provides adequate flow to sustain the vegetation, but without excessive velocities or flood durations that exceed the plant's flood tolerance; expected sediment load – excessive loads may limit ability to establish vegetation at the water's edge; shade conditions; and substrate stability – noncohesive material such as sand or silt may require longer or more frequent staking to provide secure anchoring. Once the slope is reestablished, it should be seeded, covered with an erosion blanket, and planted with plugs as necessary.

In several past applications, the planting embedded in the fiber roll that occurred at the time of installation did not survive due to the relatively sterile and dry conditions within the fiber roll. In those same applications, a second planting that occurred after the roll had become silted was quite successful as the accumulated silt provided a better growing medium and helped retain moisture within the roll. The narrow bank of emergent habitat provides cover, resting, and foraging opportunities for macroinvertebrate, small fish species, and wading birds.

Advantages:

- Provides short-term stabilization (approximately 5 years) and a medium to establish desirable emergent and riparian vegetation that provides long-term stabilization.

- Flexibility for molding to the existing curvature of the streambank.
- Provides toe protection where scour is not severe and vegetation is sufficient to provide long-term stabilization.
- The established vegetation provides some water quality and aquatic habitat benefits and a natural looking streambank.

Disadvantages:

- Limited effective life – biodegrades in 3-5 years. If vegetation is not sufficiently established by this time, the treatment may fail.
- Requires maintenance to ensure establishment of vegetation, including replanting, etc. during the establishment period.
- Not appropriate for sites with severe scouring, high velocity flows, or large ice build-up.
- There must be sufficient sunlight available for colonizing plant growth.
- Should only be installed in areas with low flow velocities, relatively stable substrates, and where erosion pressure is low and vegetation can be established.

Maintenance:

- Periodic inspections of the coir roll will need to be undertaken to ensure stability as well as assess the establishment of native vegetation, which is critical as the fiber roll degrades.
- Plant maintenance will consist of invasive species removal, and other natural area management techniques as necessary to maintain appropriate emergent plantings.

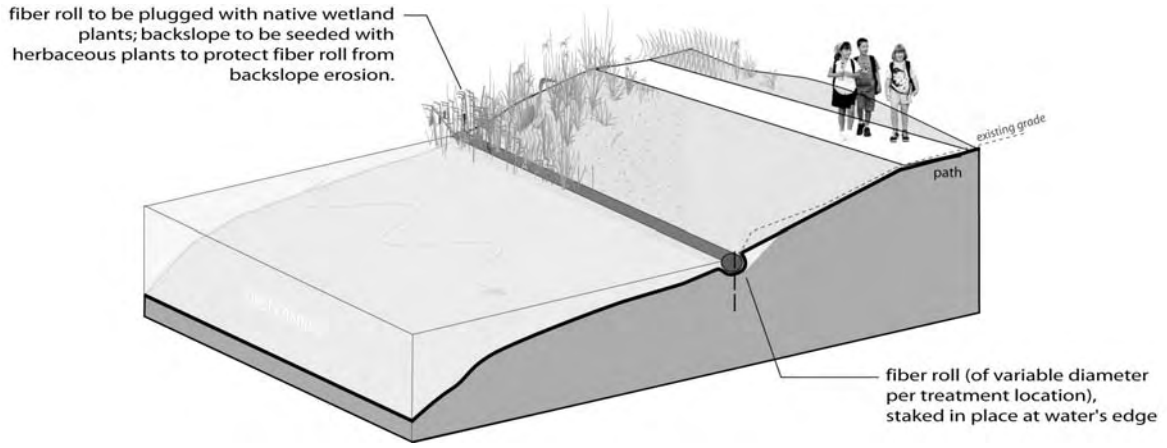


Figure 98. Fiber roll.

6. Edge Treatment - Floodplain Wetland/Aquatic Shelf

This treatment involves cutting back the existing bank to create a shallow aquatic shelf that would support native emergent and aquatic vegetation. The newly created slope should be planted with native riparian vegetation. Applicability of this treatment is limited to areas with sufficient space to allow grading the banks back a sufficient distance to create a shallow shelf. The width of the shelf could be as little as 5 feet or as great as 50 or more feet to create a backwater "slough." This treatment can significantly increase aquatic and riparian habitat. With adequate width and vegetation establishment, flow and wave erosion pressure at the water's edge can be substantially reduced. However, it may be necessary to provide some level of hardened stabilization at the edge of the channel (but below the normal water level). The reestablished slope should be seeded, covered with an erosion control blanket, and planted with native plugs as necessary.

The establishment of different plant communities along the hydrologic gradient (e.g., permanently inundated to saturated soil conditions), provides the chance for a diversity of vegetative species. This in turn provides the opportunity for a diversity of fauna species within the varied microclimatic habitats. The width of created wetland habitat will determine the various usages of the habitat; less width will provide some cover and foraging opportunities; more extensive width (50 feet or greater) will provide better cover, more foraging opportunities, and potential for nesting habitat.

Advantages:

- If properly integrated into the streambank and adjacent landscape, floodplain wetland/aquatic shelf can provide long term stabilization of the shoreline.
- Creates excellent wetland and aquatic habitat for a variety of aquatic wildlife.
- Elevation of the shelf relative to normal water level and the degree of direct connection with the stream can be varied to achieve different plant community and habitat goals.

Disadvantages:

- Adequate landward space is required to create the shelf and the back slope.
- Depending on the height of bank, the amount of material to be removed may be very large, therefore costly.
- Excessive silt deposition could limit plant communities that can be established.
- Requires commitment during vegetation establishment period.
- Long-term commitment for monitoring and management.

Maintenance:

- Interface between shelf and channel will need to be inspected for scouring.
- Routine management of plant communities, typical of other created wetlands, including control of invasive vegetation and burn management.
- Replacement of lost vegetation.

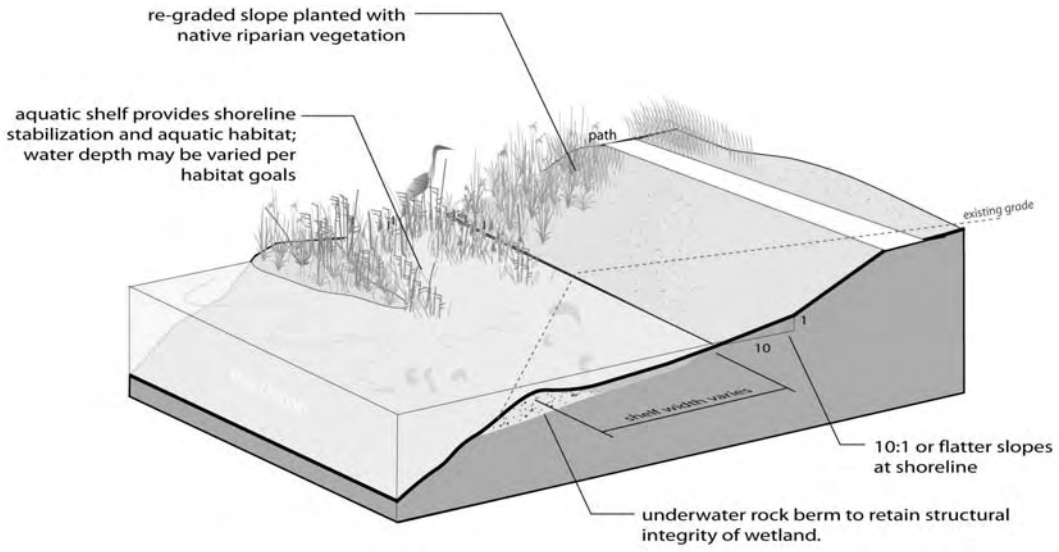


Figure 99. Aquatic shelf.

7. Streambank Treatment - Lunker Structures

This treatment is used to provide both bank stabilization and fishery habitat. Lunker structures are used to stabilize the toe of the bank and create an artificial undercut bank, which serves as cover for various fish species. Lunkers can be constructed out of recycled plastic or lumber. These structures are placed at the outside toe of bends in pool areas. Excavation of bank material may be necessary that when the lunker is placed at the toe zone, the front of the structure is in line with the original bank. The area behind the lunker is filled with rock and fill is placed over the lunker to restore a more gradual bank slope. The reestablished slope should be seeded, covered with an erosion control blanket, and planted with native plugs as necessary.

Advantages:

- Provides overhanging shade and cover habitat for fish.
- Stabilizes the toe of the streambank.
- Relatively cost effective.

Disadvantages:

- Longevity a potential concern as soil may be scoured from top of lunker.
- Limited applicability

Maintenance:

- Periodic inspections to assess the integrity of the seeded bank slope and endurance of this technique.

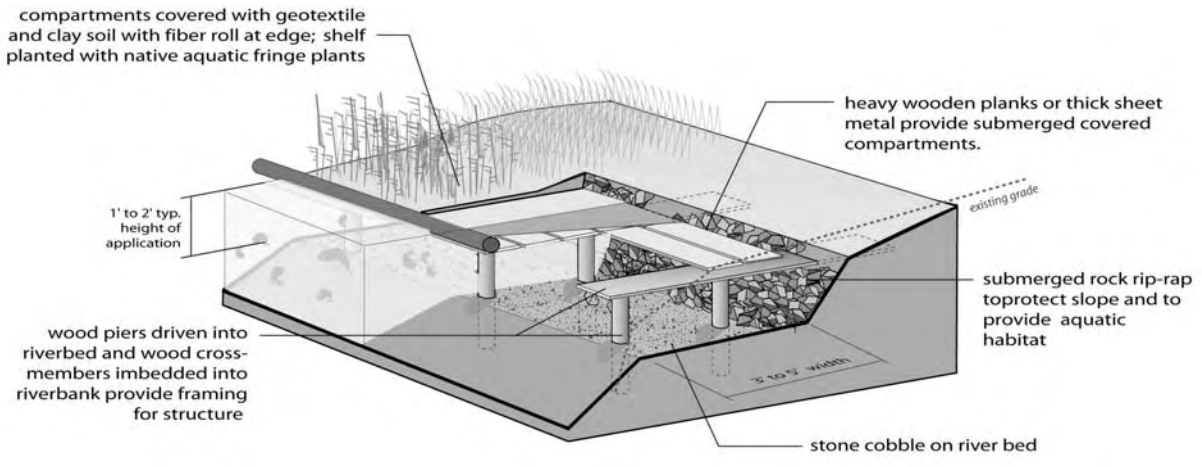


Figure 100. Lunker structures.

Slope Treatments

1. Slope Treatment - No Grading

In areas where the bank slope is relatively stable, no regrading of the slope is necessary. However, there are likely areas where dense growth of invasive trees and shrubs with insufficient groundcover is leading to surface erosion. Tree canopy should be selectively thinned to allow sunlight in order to establish native riparian cover to address surface erosion.

The reestablishment of a native vegetative cover, which is primarily native grasses and forbs, will provide cover habitat and a food source for small mammals and birds, as well as a breeding habitat and food source for insect species. If native shrub species are interplanted within the prairie or savanna communities, this will provide an additional layer of structure for breeding, foraging, and cover opportunities for wildlife.

Advantages:

- No major site disturbance – allows retention of existing desirable trees.
- Vegetative management creates an environment for native plant growth and wildlife.

Disadvantages:

- Where slopes are relatively steep but stable, access down to the water may be limited.
- Success of long term slope stability may be dependent upon vegetative establishment.
- Establishment of vegetation may be difficult on steep, shaded and north facing slopes.
- Where slopes are steep and high, toe stabilization is critical to maintain slope stability.

Maintenance:

- Burn management is recommended for establishment of a native vegetative community.
- Initial establishment period (years 1–3) would require intense weed control through mowing or string trimming, and herbicide treatment for undesirable vegetation.

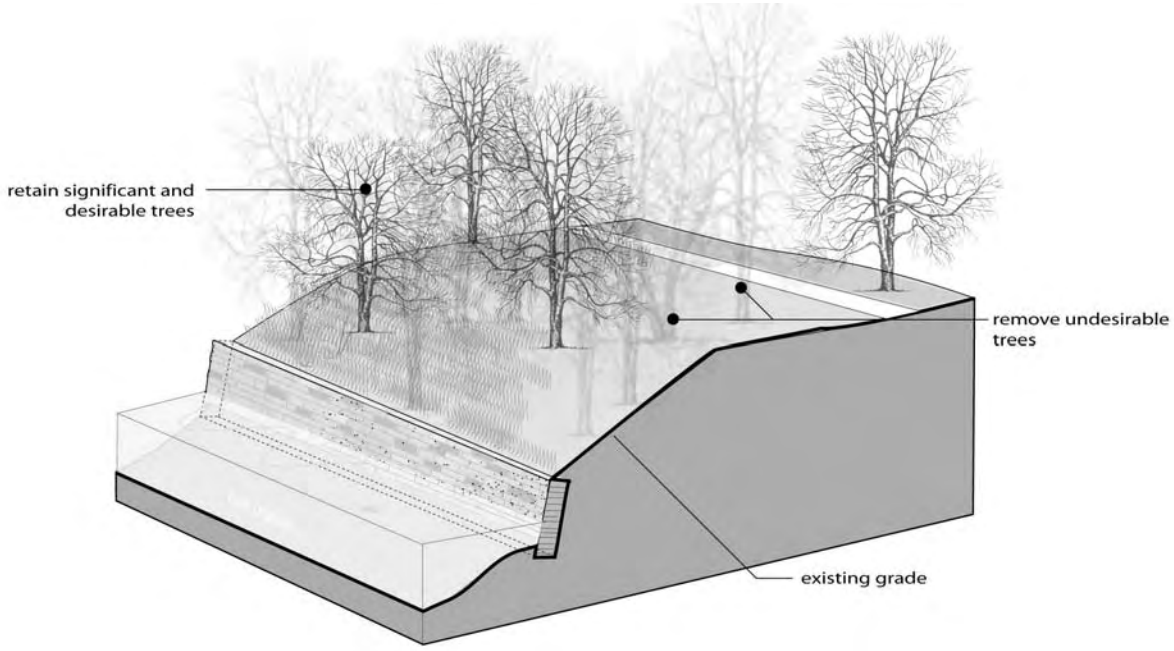


Figure 101. No-toe slope.

2. Slope Treatment - Regrading

Where bank slopes are steep and unstable, regrading may be required. In most cases, regrading will require partial or complete removal of existing vegetation (trees and other vegetation). This provides an opportunity to plant more desirable riparian tree species and native vegetation. The establishment of deep rooted native herbaceous plant communities on the regraded slopes is necessary to prevent soil erosion. Erosion blankets must be used to provide temporary protection against sheet and rill erosion and to facilitate vegetative establishment.

The potential wildlife habitat for this treatment would be similar to the no grading treatment option (if native communities are reestablished under that treatment application). However, this treatment may create a wider habitat depending upon the extensiveness of the proposed grading. Development of a wider habitat provides increased potential of breeding conditions for some bird and small mammal species. For example, data collected of minimum, riparian buffer strip widths required to support breeding bird populations in Iowa resulted in more generalist species such as cardinal, black-capped chickadee, and downy woodpecker requiring buffer widths of 11 to 15 meters. Midrange buffer widths of 35 to 90 meters supported bird species such as great crested flycatcher, hairy woodpecker, and red-eyed and warbling vireos. More substantial buffer widths, 150 to 200 meters, are needed for more specialists.

Advantages:

- Structures not needed to stabilize slopes, providing a natural appearance.
- Immediate solution creates "clean template" to establish desired plant communities and provides appropriate slopes minimizing erosion problems.

- The establishment of native vegetative communities provides wildlife habitat opportunities and creates a pleasing aesthetic.

Disadvantages:

- Usually requires removal of many or all existing trees, shrubs, and other vegetation, which creates a temporarily barren landscape.
- Establishing trees and herbaceous vegetation is necessary.
- Requires room to perform regrading.

Maintenance:

- Routine inspection of new vegetation establishment.
- Invasive species control including but not limited to burn management, mowing, string trimmer, herbicide treatment, etc.
- Replanting and reseeding as necessary.

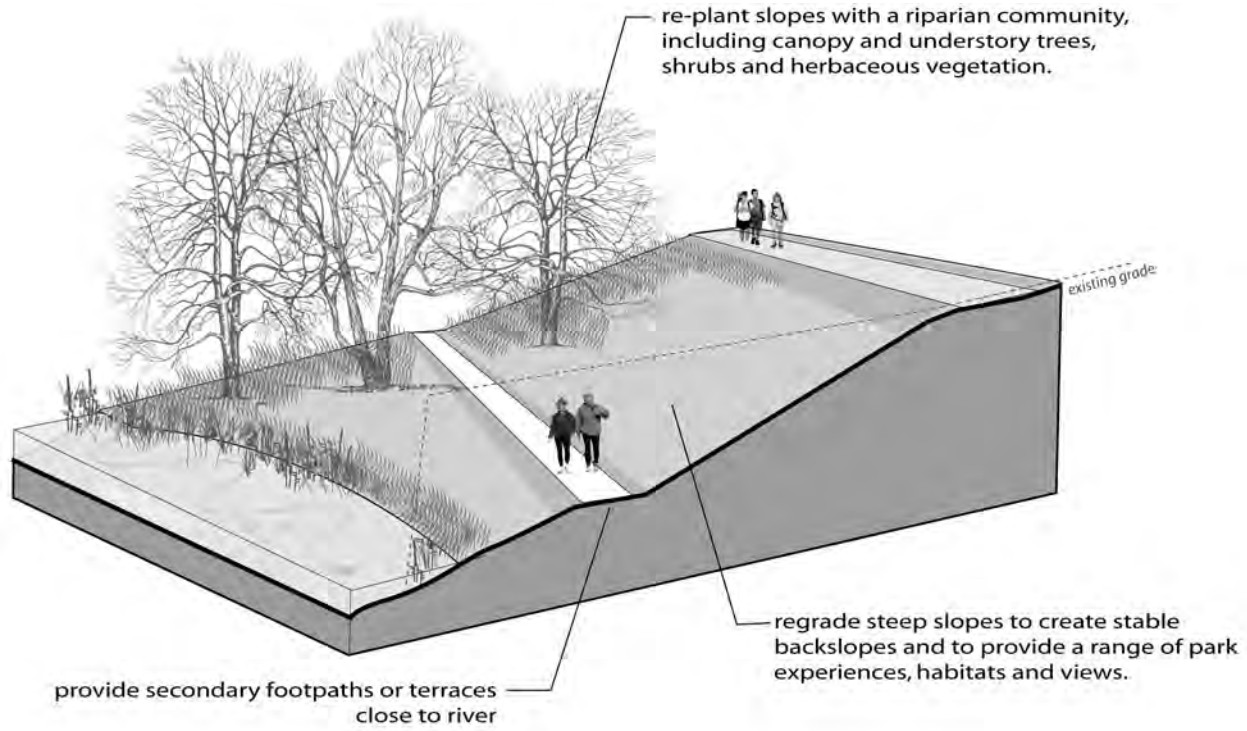


Figure 102. Regrading.

3. Slope Treatment - Retaining Walls

Retaining walls stabilize the slopes by retaining the soil behind them. The wall can be made from a variety of durable materials such as sheetpile, timbers, stacked rock, poured concrete, stone or gabions. Retaining walls can be located at the stream edge where they can be an extension of a wall or can be placed back from the stream edge to allow for a trail or other uses between the edge and the back slope. Also, the materials selected can impact the aesthetic of the wall. This treatment type does not provide any habitat benefits.

Advantages:

- Can be placed at shoreline or further landward to accommodate trails and amenities.
- Provides access to water's edge.
- Presents opportunity to integrate overlooks and steps in an artful way.

Disadvantages:

- There may be significant floodway permitting issues where the retaining wall is used to reduce the cross-section of the channel.
- Retaining walls are generally the most expensive means of slope stabilization
- Retaining walls tend to isolate the stream from its corridor and associated habitat.

Maintenance:

- Periodic inspection for tipping and bulging.
- Possible vandalism where the wall is constructed of movable material (stacked stone).

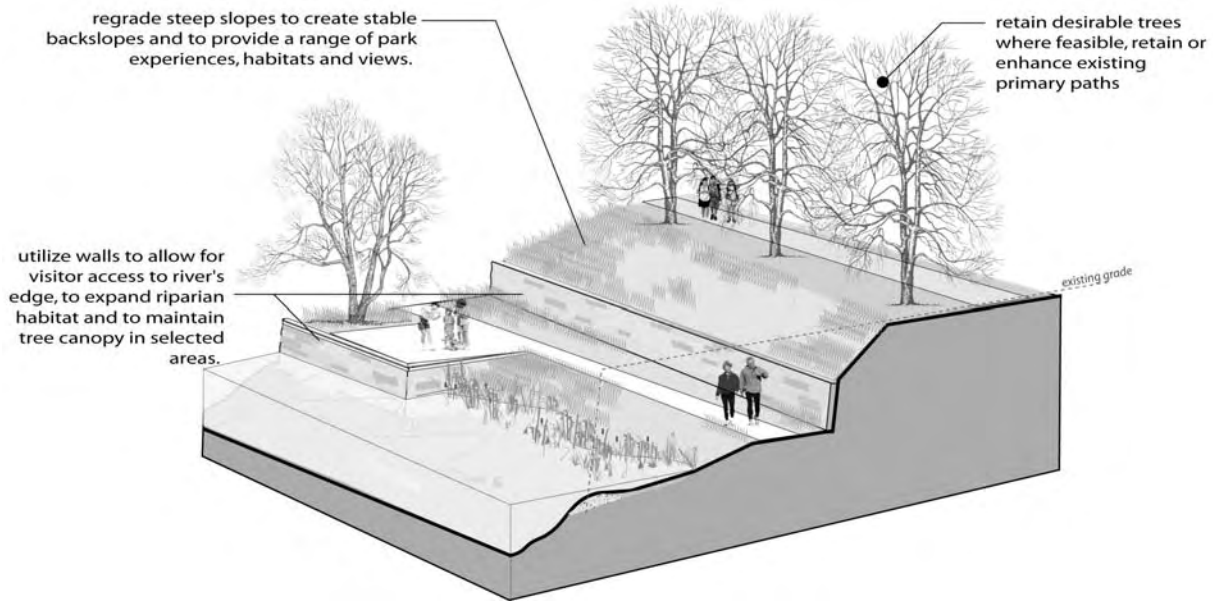


Figure 103. Retaining walls.
(Note: The "retaining wall" slope treatment is shown with "retaining wall and wetland fringe" toe of slope treatments.)

4. Slope Treatment - Compacted Soil Lifts

Soil lifts are typically used to reconstruct failed slopes and allows for the creation of steeper slopes than would normally be feasible with regrading alone. This slope treatment consists of fabric reinforced soil lifts (compacted layers) seeded and planted with native vegetation. Compacted soil lifts are generally installed with a stone toe or A-jacks to provide a foundation and toe protection. The stone provides a drainage layer to reduce the duration of saturated bank conditions that can lead to bank slumping. The fabric provides temporary stability and protection from erosive forces before the native vegetation can become established and provide long-term stability.

In many applications, the soil lifts are constructed in the location of a former slump to replace lost bank material and reestablish a continuous slope along the reach. In other applications, compacted soil lifts may be used where bank regrading is not an option due to space constraints.

This treatment would provide some potential cover and foraging habitat opportunities similar to the "no grading" alternative. However, due to the steeper gradient of this treatment, it would be more limiting for wildlife usage. This method of stabilization would most likely be used in limited scenarios such as a bank "blowout" due to lateral runoff, and the application of the treatment would not be widespread.

Advantages:

- Can be used on steeper and higher banks than the regrading option.
- Can be used to rebuild bank slope where soil has slumped away.
- Creates environment for native plant growth and wildlife habitat.

Disadvantages:

- More expensive than regrading.
- May require importing of suitable soils if existing material is unsuitable for bank stability.
- For successful treatment, this technique must be combined with the stone toe or other hardened shoreline treatment.
- System must be built during low flow conditions.
- Erosion blanket biodegrades in 5-7 years.

Maintenance:

- Vegetative management during the vegetation establishment period.
- Periodic inspection to identify and address evidence of slope failure.

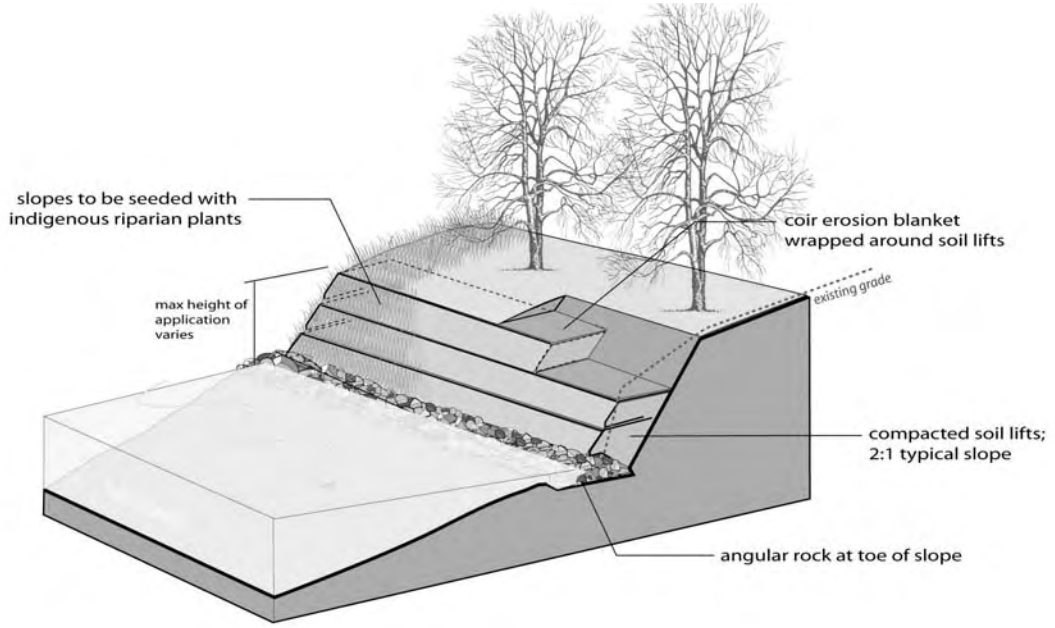


Figure 104. Compacted soil lifts.

5. Slope Treatment - Riprap

This treatment involves layered angular stone that protects and stabilizes banks that are subject to erosion within areas of poor soil structure. The stone should be underlain by a filter blanket of gravel or synthetic material to prevent migration of soil through the rip rap.

The voids in the riprap may be filled with soil and interplanted with vegetation to soften the appearance and improve habitat and water quality benefits. Although a portion of the soil may erode away over time, the rip rap prevents the bank from receding further and the vegetation will tend to mask the rock. This variation riprap is similar to vegetated gabions.

Advantages:

- Well suited for locations of high flow or wave energy that impinges higher on the slope than toe protection measures. Examples include locations of large waves and large water level fluctuations.
- Can be used to protect steeper slopes where regrading to relieve flow or wave energy is not feasible.
- Can appear quite natural when layered with soil and vegetation.

Disadvantages:

- May be considered unaesthetic in some locations, especially if unable to be interplanted with native vegetation.
- Limited wildlife habitat opportunities when not layered with soil and vegetation.

- Moderately expensive although less than retaining walls.
- Potential for vandalism. Stone can be thrown into stream.

Maintenance:

- Low maintenance required; periodic inspections to assess if rocks have subsided.

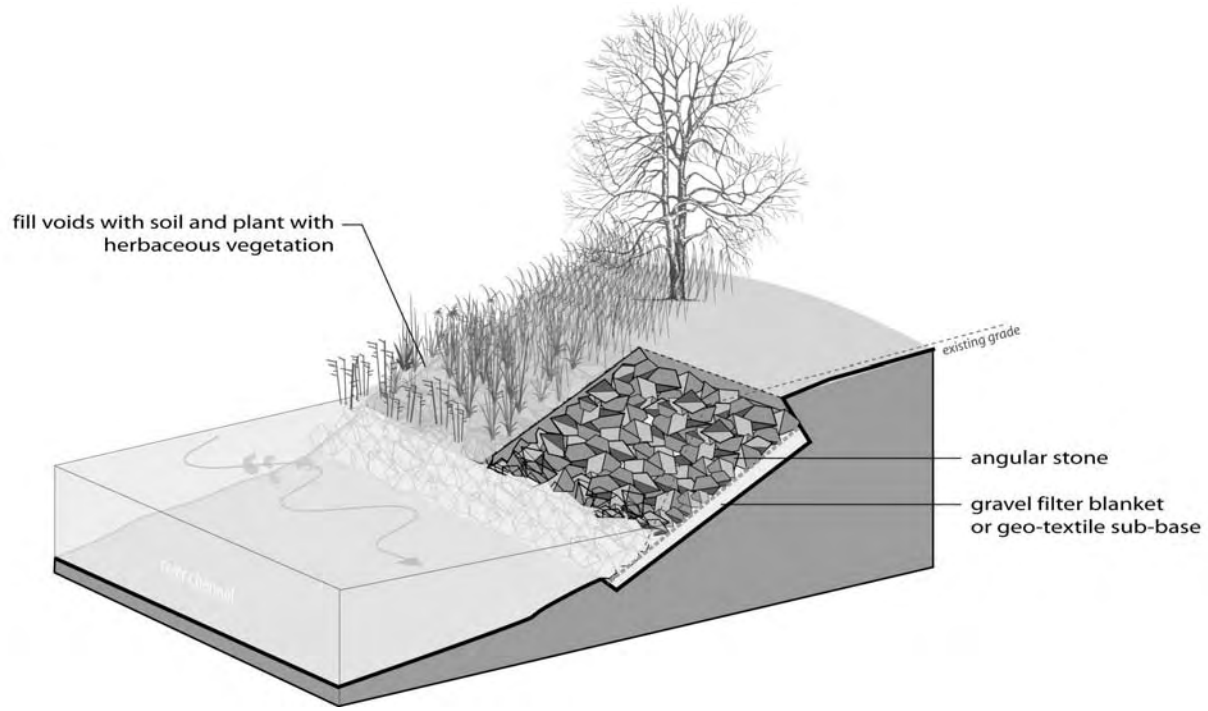


Figure 105. Riprap.

2. Establish riparian buffers along stream corridors

Introduction

Riparian buffers help to protect water quality by filtering overland run-off and pollutants. Vegetative buffers that edge watercourses for a minimum of 100 feet on either side help maintain good water quality by controlling erosion, sediment, and the flow of pollutants into watercourses. Healthy riparian communities can contribute to various important functions: sediment filtering, bank stabilization, water storage and release, and aquifer recharge. This CLR recommends that the park establish and manage Resource Protection Areas—margins of creeks, rivers, and other bodies of water—and Resource Management Areas—isolated wetlands, floodplains, highly erodible soils, and highly permeable soils—to protect water quality. Vegetation management, particularly the establishment of riparian buffers, is one of the tools that supports this goal. All resource protection areas and resource management areas fall within the Water Resource Protection Management zone described in Chapter 6. It must be noted, however, that until the surges in creek flow can be abated through control of overland flow throughout the watershed, no money should be spent on the establishment of riparian buffers within the floodplain of the creek. The force of the water that currently moves through the system during and after a storm event is so powerful that it will carry away any plantings and other streambank restoration techniques that are applied. It will be crucial for the park to work with upstream neighbors to contribute to the infiltration of precipitation and overland stormwater flow before implementation of the project can proceed. The park can serve as a leader in this effort and set an appropriate example as part of the outreach effort that will be necessary.

Riparian buffer vegetative composition can vary greatly, but many of the trees, shrubs, and grasses native to the region can be used successfully. Typically, riparian buffers are comprised of a series of zones or bands of native vegetation that parallel the margins of the watercourse. The objective at Wilson's Creek is to utilize primarily fibrous rooted grasses for buffers, although open-grown trees will also likely be a component. These would be visually consistent with the savannas that are a desirable condition elsewhere in the park, but comprised of species adapted to the soil moisture conditions of the riparian zones. Natural resource managers familiar with the park and region can help select plants that are appropriate for the buffer.

By law, any landscape management activity that moves, breaks, or disturbs soil requires some level of Section 106 and/or National Environmental Protection Act compliance review before activities can begin. The compliance process must be completed before any ground-disturbing activity can occur within the riparian buffer zone.

Location of Project

Once the watershed begins to recover, the main stem of Wilson's Creek is an area where a riparian buffer may one day be appropriate. The first priority areas for implementing this project include the Gibson Mill's site, Short spring, park bridge abutments, Wire Road ford site, and equestrian trail fords.

Considerations

It is not recommended that any treatment be applied initially within the 2-year floodplain along Wilson's Creek. The magnitude of this effort may justify a separate hydrological study to define

watersheds, identify crucial resources to protect, identify active problem areas, and determine the most cost-effective approach.

Recommendations

Identification and Evaluation

- Delineate buffer boundaries for all perennial water bodies and wetlands using Global Positioning Systems.

- Conduct site visits and field surveys using NPS natural resource specialists to evaluate the current state of the vegetative communities within riparian buffer zones. Note the width, density, composition, and health of its existing buffer zone vegetation.

Considerations

Existing Riparian Buffers

- Retain existing vegetation that is consistent with a riparian buffer in composition. Establish a program to perform cyclical maintenance and monitoring thereby ensuring the continued effectiveness and health of the appropriate vegetative composition.

- Rehabilitate buffers using BMPs for forestry if the buffer is not stable—for example, if vegetation is in poor health, there are numerous invasive plants, or the existing buffer is too narrow. Remove invasive plants using the guidelines provided in this document.

- Plant native vegetation as needed, and implement maintenance and management practices that support the establishment of additional buffer area if its width or density must be increased.

- Consider riparian buffer conservation as part of all park landscape management planning and implementation strategies.

- Provide educational and/or interpretive information to park employees and visitors on the value of riparian buffers and the goals of buffer conservation projects. Consider using waysides, signage, or other means to interpret buffers on-site.

New Riparian Buffers

- Implement a minimum 100-foot-wide riparian buffer strip on either side of watercourses and wetlands where buffers do not exist, or in places where existing buffers do not comply with NPS management objectives. Begin by identifying potential buffer locations and delineating minimum buffer boundaries. Involve park staff, including natural resource specialists, in the process.

- Delineate the extent of the minimum 100-foot-wide buffer zones for different types of water bodies.

  — Wetlands: delineate wetlands, or use existing delineation information, to establish the extent of Resource Protection Areas.

— Water bodies with perennial flow: determine whether existing streams and other water bodies maintain a perennial flow.

- Determine whether a riparian buffer or other type of vegetated buffer is appropriate given the interpretive goals for an area, as well as park management objectives, after delineating the proposed extent of the buffer. For example, establishment of a woody riparian buffer may not be compatible with an interpreted viewshed corridor; in some locations tree growth may lead to a negative impact on a cultural or archeological resource. Alternative buffer types for those situations are discussed later in this section.

- Consider the potential for appropriate buffer vegetation to arise naturally. Natural processes should be supplemented with silvicultural practices as necessary. Interventions into the process may be necessary where invasive plant species are a threat to native riparian vegetation, and where watercourses have unstable hydrologic conditions due to upstream construction, industry, or development.

- Avoid mowing within delineated riparian buffer zones.

- Control colonization by invasive species.

- Plant appropriate native and/or regional vegetation including woody and herbaceous species as needed.

Implementation

- Examine current site conditions to determine potential plant selection and the condition of the water resource by evaluating the following elements:

  —Soil type(s)

  —Slopes within buffer zone

  —Stability of soil organic layer

  —Vegetation type(s) and communities

  —Hydrology

  —Type and condition of adjacent waterway

  —Land use history

  —Location of cultural and archeological features

- Prepare the site for buffer establishment by removing invasive vegetation and refuse, and by protecting sensitive natural or cultural resources. Remove woody plants that are not consistent with an open-grown savanna community. Refer to guidance provided elsewhere in this chapter regarding control of invasive plants.

- Plant vegetation that is native within local riparian zones. Grasses should primarily constitute the buffer. Include a combination of dense native grasses, forbs, and small shrubs.

- Select species based on site conditions. Ecologists and plant specialists should determine the species compositions, the densities that will be required, and the appropriate season for planting. Soil disturbance, seed scarification, dormant periods, and plant species invasion are all dependent on seasonal changes. At Wilson's Creek, cross-reference recommended plant lists with information regarding species composition within the region during the Civil War period. Select historic varieties as practical.

- Follow proper plant installation methods, including mulching and watering techniques, to ensure survival of vegetation. During plant installation, follow erosion control methods to prevent excessive sediment or chemical run-off into the adjacent water body.

- Monitor post-installation site conditions for plant health and possible invasive plant species growth. Replace failed vegetation immediately.

Alternative Buffers for Establishing Viewsheds

At Wilson's Creek, certain viewsheds are critical to the visitor's understanding of the 1861 battle. Where interpreted viewsheds and sight lines are desired, standard riparian buffers should be replaced by alternative, lower-growth buffers.

- Consider alternative buffers to maintain the open viewshed between Bloody Hill and the Ray House.

- Utilize only native grasses and forbs at sites where trees are judged to be incompatible with interpretive or management objectives. Select species with a strong fibrous root system that will help stabilize the soil.

- Maintain alternative buffers through burning.

- Consider selectively removing trees from existing riparian areas to establish or maintain interpreted view corridors. Conserve or establish understory grasses and forbs in locations where trees are removed. Consult with an arborist, archeologist, and natural resource specialist to determine the best method for the selective removal of trees within buffers and the prevention of resprouting and growth of invasive species.

3. Rehabilitate glade communities

Introduction

Glades are a result of years of erosion that exposes bedrock near the land surface. Certain plant species have adapted to glade conditions by maintaining long slender taproots that grow into the cracks of the rock, and fleshy stems and leaves that have an ability to drop off to reduce water loss. Some glade plants grow only during the winter and spring when water is abundant and temperatures are lower.

Prior to European-American settlement, the glades were completely open with an occasional tree of blue ash (*Fraxinus quadrangulata*), chinquapin oak (*Quercus prinoides* var. a*cuminata*), or post oak (*Quercus stellata*). Perennial and herbaceous species visible in the spring and summer months included Indian paintbrush, larkspur, shooting star, yellow coneflower, prickly pear cactus, and bird's foot violet. In the summer, prairie dock (*Silphium terebinthinaceum*), Missouri evening primrose (*Oenothera missouriensis*), and purple prairie clover (*Petalostemum purpureum*) were prevalent. Prairie grasses frequently found in glades included Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), and little bluestem (*Schizachrium scoparium*). Glades contain conservative lichen species that grow nowhere else.[1]

Once nearly treeless, the remnant glade communities at Wilson's Creek NB are now threatened by a proliferation of Eastern redcedar (*Juniperus virginiana)*. The cedars shade out native species and cool the substrate below. This cooling effect changes the mass-heat relationships of the exposed bedrock on which native glade plant and lichen species are dependent. The shaded conditions have allowed for a proliferation of invasive Asian annual grasses such as Japanese chess (*Bromus japonicus*), which in addition to the cedars, will require management to control.

Although scarcely resembling their former extent or character, the glades still retain a number of conservative lichens and herbaceous plant species and should be classified as significant natural features to be protected. With proper management, these areas will become healthier, increasing the habitat potential for the park's endangered plant species, in particular, the Missouri bladderpod (*Lesquerella filiformis*).

Location of Project

The glade plant communities within Wilson's Creek NB are scattered across the site *(see figure 93, Park Plant Communities map)*. Relatively high-quality glade remnants exist atop the hill west of the Sharp crop field, on the west-facing bluffs of Wilson's Creek, above the old railroad bed (in the vicinity of the Manley cemetery), and along a nose slope near Short's Branch.

[1] Conservatism represents the degree to which an experienced field botanist has confidence that a given plant species is representative of a high-quality, remnant habitat (i.e., those natural areas with intact presettlement structure, composition, and processes). Native plant species display varying degrees of tolerance to disturbance, as well as varying degrees of fidelity to specific habitat integrity.

Recommendations

Consider the following two alternative methods for rehabilitating glade communities at Wilson's Creek:

Alternative 1

Identification and Evaluation

- Conduct site visits and field surveys with natural resource specialists to evaluate the current state of vegetation in and adjacent to glade communities.
  - — Identify adventive and invasive species, such as Eastern redcedars, to be removed.
  - — Mark cedars and other vegetation to be removed.
- Prioritize glade restorations with higher quality communities, particularly those containing threatened or endangered species.
- Specific objectives of the restorations include:
  - — Elimination of all *non-native* species within a designated project area.
  - — Reduction of cover and stem density of invasive *native* shrubs and small trees within a designated project area.
  - — Control of resprouts of invasive species removed during the clearing process.
  - — Disposal of cut brush by chipping or stacking in small burn piles and burning in designated areas.

Considerations

- Where glade communities are more open, annual or frequent prescribed burns may be the only form of management necessary to rehabilitate the community.
- Manage glade communities in conjunction with adjacent savanna and prairie communities. Avoid making firebreaks at the edges of these plant communities; allow fires to run from one community to the next.
- Coordinate restoration activities among the various plant communities to maximize efficient use of labor and equipment and to minimize site activity/disturbance in any one restoration area.
- Allow mechanical clearing of cedars and other woody material only under conditions of very dry or frozen soils to ensure there is no rutting/pitting or other damage to the soil.
- Consider allowing only hand cutting with chain saws, brush clearing saws, handsaws, and loppers in sensitive areas.

- Consider restricting herbicide application techniques in remnant (glade or savanna) areas to wick or sponge applications.

Implementation

- Preserve and rescue any open-grown heritage trees by removing pole-sized trees and any other encroaching vegetation beneath the canopy.

- Remove Eastern redcedars outside of the bladderpod growing season, which runs through the summer months and into early fall, usually from June 15 to September 30. Chip and dispose of debris off-site, or burn it in a series of small brush piles placed in disturbed areas that are not remnant or glade communities.

- Remove all non-native species and continue to experiment with techniques to control the growth of invasive species such as the Old World annual brome grasses—*Bromus sterilis* and *Bromus tectorum*—as they occur (see guidelines for updated invasive species control plan). In areas thought to contain bladderpod populations, avoid use of herbicide during its growing season.

- Seed native grasses such as little bluestem (*Schizachrium scoparium*) as necessary to provide fuel load and perennial competition for the Old World annual bromes.

- Begin regular prescribed burns as fuel loads permit (see guidelines for landscape stewardship in Chapter 6).

- Monitor progress of restoration and determine management needs (see guidelines for landscape restoration monitoring in Chapter 6).

Alternative 2 (provided to team by park)

In glades with Missouri bladderpod:

- Remove mechanically Eastern redcedars every three years outside of the bladderpod growing season, which runs through the summer months and into early fall, usually from June 15 to September 30.

- Burn every five years before fall germination of bladderpod, which occurs in late summer or early fall (usually the last two weeks in September).

- Remove cedars from bladderpod habitat and chip or burn.

- Seed natives if necessary to sustain maintenance burns.

- Control brome grasses by cutting seed heads at dough stage (usually the last two weeks of April).

In glades without Missouri bladderpod:

- Cut cedars mechanically every three years, at any time of year before burning, and pile under other cedars.

- Burn every two to five years to match the frequency in surrounding areas.
- Seed natives if necessary to provide fuel for maintenance burns.

4. Rehabilitate savanna communities

Introduction

Missouri is in a broad transition zone between the forests of the East and the grasslands of the Great Plains. Fires set by American Indians, as well as grazing by bison and elk, created a broad ecotone between grassland and woodland for thousands of years across the landscape. At the time of statehood, nearly a third of Missouri may have been savanna or woodland.

Although degraded, the savannas and mixed forests at Wilson's Creek NB represent a valuable part of the state's natural heritage. They support a variety of oaks: post, bur, blackjack, black, chinkapin and white. The preponderance of oaks provides large acorn crops—high energy food for wild turkey, white-tailed deer and squirrels.

Savannas consist of widely spaced trees—mainly oaks, with occasional hickories—growing over an open understory which allows enough sunlight to support a thick ground cover of native grasses, forbs, and sedges. It was these sedge species, like the grasses of the prairie, that formed two essential matrices in the system. Organic matter was sustained by the fibrous root systems, and the aboveground fine fuel produced by their leaves controlled the intensity and nature of the ground fires set by American Indians each fall.

Savannas typically occur in association with prairies, and are somewhat like prairies with trees. Mixed forests, by comparison, have a closed overstory of trees with an open understory. At Wilson's Creek, many of the post-agricultural woods are so dense with young trees that the ground is too shaded to support sedges, forbs, and grasses. Like savannas, the mixed forest canopies also contain oaks, but at Wilson's Creek the oaks are more sparsely distributed.

The savannas and mixed forests at Wilson's Creek NB are overcrowded with pole-sized, evenly-aged trees, which are growing at densities far higher than those recorded historically on the Springfield Plateau. These communities have lost their native groundcover due to extensive shading, overgrazing, and competition from invasive species. Restoration of these areas is critical to the stabilization of Wilson's Creek.

Fire was crucial in the historical development of Missouri's savanna and woodland heritage. Over the years, the park has used prescribed burning to help restore and manage its prairie landscapes, but these areas would benefit from more frequent prescribed fire. In the woodlands, this would help to open up the canopy and allow for the reestablishment of a healthy groundcover community.

Location of Project

Savanna and mixed forests communities are scattered across Wilson's Creek NB *(see figure 93, Park Plant Communities Map).* A relatively high quality remnant of savanna exists along the west-facing bluffs of Wilson's Creek, above the old railroad bed.

Consider the following two alternative methods for rehabilitating savanna at Wilson's Creek:

Recommendations

Alternative 1

Identification and Evaluation

- Conduct site visits and field surveys with natural resource specialists to evaluate the current state of vegetation within the wooded landscapes:
  - — Determine tree removal goals.
  - — Identify invasive species and include in removal goals.
  - — Identify and mark vegetation to be removed or preserved.
- Prioritize restoration zones with remnant communities, particularly those containing special status species.
- Specific objectives of the restorations include:
  - — Elimination of all *non-native* species within a designated project area.
  - — Reduction of cover and stem density of invasive *native* shrubs and small trees within designated project area.
  - — Control of resprouts of invasive species removed during clearing process.
  - — Disposal of cut brush by chipping or stacking in small burn piles and burning in designated areas.

Considerations

- Consider that, in areas where savanna communities are more open, annual or frequent prescribed burns may be the only form of management necessary to rehabilitate the community.
- Consider that if a remnant such as Manley Woods has the fuel load to carry a fire, it may be preferable to burn three consecutive years prior to beginning any clearing work. At that point, the park could assess the trees that were eliminated by the fire and then evaluate the area to determine removal goals; the exception being the tornado-damaged areas, which must be cleared of downed trees to burn.
- Consider that the current density of the canopy in the mixed forests filters the majority of the light (more than 95 percent) that would otherwise reach the ground on a July day at noon. The light levels at which these communities evolved was likely closer to 10 or 20 percent of available sunlight.[2]

[2] Gerould Wilhelm, "Implications of Changes in Floristic Compositions of the Morton Arboretum's East Woods" (Lisle, IL: The Morton Arboretum, 1991); and Gerould Wilhelm and Linda Masters, "Floristic Changes after Five Growing Seasons in Burned and Unburned Woodland" (Lisle, IL: The Morton Arboretum, 1994).

- Consider girdling trees selected for removal that are over 10 inches in diameter (dbh). Girdling involves cutting a groove or notch into the trunk of a tree to interrupt the flow of sap between the roots and crown of the tree. The groove must completely encircle the trunk and should penetrate into the wood to a depth of at least 1/2 inch, preferably 1 to 1-1/2 inches on larger trees. Girdling ultimately results in the death of the tree. This method is often more cost effective than the actual removal of a tree, but is not recommended near trails, roads, or other areas of public access.

- Consider existing species compositions in developing removal goals:

  — Selectively remove invasive tree species by percentages based on the composition of the woodland to be restored. A higher quality savanna densely populated with oaks would have different removal goals than a mixed forest that contains mostly pole-sized trees of lower quality species. The following is an example of removal goals that may be designed for an area following analysis.

  Removal Goals

  Non-Native and Aggressive Native Species *, ** - 100% Removals

  Multiflora rose
  White mulberry
  Autumn olive
  Osage orange
  Eastern redcedar
  Japanese honeysuckle
  Amur honeysuckle
  Black Locust
  *(Plus any other non-native species encountered) **(Trees >10" dbh may be girdled)

  Aggressive Natives - Selected Removals* (as indicated)

Honeylocust	100% removal of stems < 18" dbh
Siberian elm	100% removal of stems < 18" dbh
American elm	100% removal of stems < 18" dbh
Red elm	100% removal of stems < 18" dbh
Wild black cherry	100% removal of stems < 16" dbh
Hackberry	100% removal of stems < 14" dbh
Juglans nigra	100% removal of stems < 14" dbh
Red mulberry	100% removal of stems < 8" dbh

  *(Trees >10" dbh may be girdled)

  Native Species* - Do Not Remove

  Oaks (this may not be true in remnant areas where oaks may be too densely disposed, in which case they would be selectively removed)

  *(Plus any other native species encountered, unless otherwise specified in Removals above)

  These particular removal goals favor a remnant savanna area. In a degraded mixed forest, there may be no oaks; therefore, the specimen trees selected for preservation may include such species as elm, cherry, hackberry, and walnut.

- Manage savanna communities in conjunction with adjacent glade and prairie communities. Avoid making firebreaks at the edges of these plant communities; allow fires to run from one community to the next.

- Coordinate restoration activities among the various plant communities to maximize efficient use of labor and equipment and to minimize site activity/disturbance in any one restoration area.

- Allow mechanical clearing of trees and other woody material only under conditions of very dry or frozen soils to ensure there is no rutting/pitting or other damage to the soil.

- Consider allowing only hand cutting with chain saws, brush clearing saws, handsaws, and loppers in sensitive areas.

- Consider restricting herbicide application techniques in remnant areas to wick or sponge applications.

Implementation

- Locate open-grown historic trees and rescue them by removing pole-sized trees and any other encroaching vegetation beneath the canopy.[3]

- Select higher quality trees to save, and selectively clear out others to open the canopy. This will vary by location depending on the tree species composition.

- Salvage timber where possible using sustainable harvesting practices.

- Remove all non-native vegetation and control growth of invasive species, such as multiflora rose (*Rosa multiflora*), as they occur (see guidelines for updated invasive species control plan).

- Begin regular prescribed burns as fuel loads permit. (See guidelines for landscape stewardship).

- Monitor progress of restoration and determine management needs. (See guidelines for landscape restoration monitoring).

Alternative 2 (provided to team by park)

- Salvage downed timber mechanically.

- Establish control lines.

- Protect resources (e.g. historic trees, archeological sites, cemetery, stone fences).

- Cut selected trees before each burn, especially cedars.

[3] Monika Moskal and Michelle Bowe, "Wilson's Creek National Battlefield Historical Trees Mapping Project" (Springfield, MO: Southwestern Missouri State University, 2004).

- Protect oaks and hickories against burning.
- Burn every two years.

5. Establish warm season grass fields within historic crop field areas

Introduction

It is recommended that areas known to have been used for crop fields at the time of the Battle of Wilson's Creek be maintained primarily as native warm season grass fields, with portions utilized to interpret historic crop activities (see project 12 for guidelines relating to crop field exhibits). Warm season grass fields will, at a broad level, perpetuate the appearance of historic agricultural land uses. Mowing patterns, for example, can be utilized as an interpretive aid to differentiate between areas that were in different uses (pasture, corn, hay, etc.)

Warm season grass fields are generally composed of regionally native perennial bunch grasses. They can be established using a modicum of soil amendments. Once established, they require few or no additional applications of herbicides or pesticides. Warm season grass fields can be cut over for hay production, perpetuating historic agricultural land uses, or burned. The drawbacks associated with warm season grasses include the difficulty and duration of establishment.

Recommendations

The establishment of warm season grass fields should be phased. Over a single season, only discrete areas of a manageable size should be selected for field establishment. This will allow the park to evaluate each field after a season and make adjustments to establishment procedures prior to undertaking work on additional fields.

Identification and Evaluation

- Conduct a visit to the site by park staff prior to beginning work to discuss and identify the appropriate locations for fields. Fields should only be implemented within areas known to have been used for agriculture in 1861.

- Conduct a survey of the site by an archeologist and historical landscape architect to identify any previously undocumented cultural resources prior to establishment of warm season grass fields.

Implementation

Warm Season Grass Fields, Option 1:

- Apply, during the fall prior to warm season grass field establishment, a systemic herbicide to areas where incompatible vegetation currently exists. Consider carefully the range of existing herbicides to determine the one least likely to have a deleterious effect on water resources. On relatively level fields, the root systems of the former or existing cover, if they are not mechanically disturbed, should be sufficient to hold the soil against erosion during the winter months. In sloped areas, existing vegetation should be overseeded with a temporary (annual) and non-invasive cover crop.

- Conduct prescribed fire activities in the spring to remove stubble and newly emerging seedlings, or apply more herbicide six to eight weeks before planting, and disc the fields. An alternative approach is to overseed warm season grass species and manage their needs over

the needs of cool season species such as fescue. Generally, this entails withholding lime and fertilizer and delaying mowing to allow warm season grasses to shade out the cool season species.

- Acquire, from as proximate a source as possible, a seed mixture based on native grass communities. Species will likely include Indian grass, and big and little bluestem.

- Undertake planting of seed between June 15 and July 15. Planting can be undertaken up to two weeks earlier when weeds are not a problem. Later planting allows for all weed seeds to germinate and provide adequate time to control them.

- Use a standard grain drill with a box for small seed, and a drill with a Tye picker for "fluffy" seed such as big bluestem. Follow each drill opener with a drag chain and packer wheel. Use a cultipacker to firm the soil if soft.

- Reduce grassy weed competition by mowing high during the seedling establishment period.

- After the first frost, grasses can be cut to 10 inches and baled for hay.

- During subsequent seasons, haying of established stands should occur once per year, either before mid-May or after mid-September. The grasses should be cut to 8 to 10 inches.

- Consider a schedule of prescribed fire that occurs at a frequency of no less than every three years. Varying the fire season may promote more forb diversity.

- Establish warm season grass filter strips along the margins of all trails. These filter strips can diminish soil erosion into streams and slow water run-off.

Maintain existing warm season grass fields

- Use the following guidelines for warm season grass fields where vegetative composition is in a stable condition, i.e. adventive species and woody plant growth are not a threat:

  — Mow by July 15 each year in selected areas to maintain a low density of woody brush.

  — Burn every one to three years.

- Use the following guidelines for burning warm season grass fields that have been invaded by woody plants:

  — Mow annually by July 15 in selected areas to reduce woody brush.

  — Cut selected trees before each burn, especially cedars.

  — Burn every one to two years.

6. Update invasive species control plan

Introduction

Invasive or adventive plant species have become a major part of the Wilson's Creek Battlefield landscape, even in well maintained systems. While the restoration of native landscapes within the park will play an integral role in the prevention and management of invasive species, many have already become naturalized in the landscape to the point that they appear to be indigenous. Whether introduced intentionally or accidentally to the landscape, invasive species cause the native landscapes to degrade and lose quality. The consequences of the invasion of such species ranges from merely annoying to seriously threatening to the park's natural systems and cultural resources.

Before attempting to control any undesirable plant, it is important to learn some of its characteristics. Invasive plants spread primarily by two means:

— **Runners** proliferate either by stolons (spreading aboveground) or rhizomes (growing underground).

— **Seed** is dispersed by wind, water, birds or other animals.

Some of the more common traits of invasive species include the following:

— Fast growth and rapid propagation;

— Quick adaptation to the existing environment;

— Ability to thrive in disturbed areas (wet or dry) and poor soil;

— Resistance to heat and drought;

— Deep, strong roots making them difficult to eradicate;

— Ability to spread easily by wind, water, birds, or mammals;

— Higher seed germination rate than many other plants;

— Lack of natural pests or predators—invasive species seldom show signs of disease or pest damage;

— Aggressive growth that robs soil, water and nutrients from desirable plants nearby; and

— Tendency to displace native species that provide food and habitat for wildlife.

In order to manage any invasive species, it is important to know its physiognomy.

— **Annual** plant species have a life cycle of one season, producing seeds (for next year's crop) before dying.

— **Biennial** plant species grow during the first year, and then fruit and die during the second year of growth.

— **Perennial** plant species can survive for years, going dormant or dying back each year, only to return the next growing season. They develop long vertical tap roots or rhizomes that make pulling or digging difficult. In fact, if the entire root or rhizome is not removed, the plant may return, often with increased vigor.

When invasive species appear to be well-established, the most effective action may be to prevent their spread or lessen their impacts. For certain invasive species, adequate control methods are not available or populations are too widespread for eradication to be feasible. For example, within Wilson's Creek, control of Sericea lespedeza (*Lespedeza cuneata)* control is currently focused on preventing the spread of the species to other areas of the park rather than the eradication of isolated populations.

Consideration of the environmental impacts of control actions requires that environmentally sound methods be available and judiciously deployed, especially in highly vulnerable areas. Often, further research is needed on the biology of invasive species and ecosystem vulnerability to them, and on means to detect and interdict invasive species that threaten to become established. This is when natural resource managers should utilize adaptive management practices. Natural resource managers and site stewards are often the ones gathering the "research" with their commendable efforts at controlling highly invasive species such as Asian brome grasses on the glades at Wilson's Creek. This "in the field" trial and error approach to invasive species control is often highly valuable and should be comprehensively recorded and documented in landscape restoration monitoring reports.

If an invasive species is eradicated in an area where its impact on the environment was small, recovery can be rapid. In many cases, however, disturbances caused by invasive species have multiple effects throughout an ecosystem and may be exacerbated by human alterations of the environment. For example, at Wilson's Creek, invasive species have dramatically reduced species biodiversity and altered the natural systems that once sustained the native landscapes.

Location of Project

Landscape restoration areas within Wilson's Creek NB that are under active management, stewardship, and/or monitoring.

Recommendations

Identification and Evaluation

- Evaluate current planning documents and maintenance records to determine how to appropriately update and/or modify the program.

Considerations

- Use invasive species control programs as an opportunity to educate the general public about the harm that invasive species cause, and the importance of preventing their introduction.

Implementation

- Put in place the following key elements for developing an early detection and rapid response system:
  - — up-to-date reliable scientific and management information;
  - — rapid and accurate species identification;
  - — standard procedures for rapid risk assessment;
  - — adequate technical assistance (e.g. quarantine, monitoring, information sharing, research and development, and technology transfer); and
  - — rapid access to funding for emergency response efforts, including funding for accelerated research of invasive species biology, survey methods, and eradication options.
- Allow for an adaptive approach to the management and control of invasive plant species.
  - — Establish management goals for the various restoration areas.
  - — Determine if any plant species threaten or have the potential to threaten the management goals.
  - — Determine which methods are available and most appropriate to control the invasive species of concern.
  - — Develop and implement the invasive species control plan designed to move conditions towards the management goals.
  - — Monitor and assess the impacts of the invasive species management actions in terms of the management goals.
  - — Repeat the steps again by reevaluating conclusions made in the first four steps and modify as necessary.

The invasive species control plan is implemented only after the first three steps are completed. The fifth step is necessary to periodically reevaluate the goals and the plan for modification as necessary. This is the essential "adaptive" process required by this strategy.

Appendices E and F provide a template and an actual example of a completed invasive species control plan as prepared by The Nature Conservancy (TNC).[4]

[4] The Nature Conservancy website: http://tncweeds.ucdavis.edu/products.html.

7. Establish filter strips in association with crop exhibits and parking areas

Introduction

Vegetative filter strips (also called grass filter strips or grass buffer strips) are used to filter and clean sediment, organic material, nutrients, chemicals, and other pollutants from run-off water as it leaves a non-point source. These include, for the purposes of this project: crop fields, equestrian staging areas, and Tour Road pull-offs and parking areas. Planted with densely growing or clump-forming grasses, filter strips are particularly crucial at locations edging drainages, streams, sinkholes, drainage wells, ponds, wetlands, or lakes to protect surface water. Placed between pollution sources and water resources, these planted filter systems can effectively mitigate soil erosion and polluted run-off.

In areas maintained in row crop agriculture, such as the Ray cornfield exhibit, vegetative filter strips are an important tool for capturing sediment and organic material by slowing run-off water. As water is slowed, larger soil and organic particles rapidly settle out. Smaller clay particles need a longer flow distance to settle out in the filter. Therefore, a wider strip is needed for removing finer sediments. Filter strips work best when water flows at a shallow, uniform depth across the filter. If water becomes concentrated in small channels, the effectiveness of the strip is drastically reduced. Filter strips also work best on shallower slopes.

Vegetative filter strips are a BMP for reducing run-off of some agricultural non-point source contaminants, such as soil nutrients, organic material and pesticides bound to soil particles, and are considered part of a conservation system. Filters cannot, however, remove all run-off water contaminants, and they may require replacement if sediments build and erosion gullies begin to form.

Location of Project

This project would take place in two types of areas. First, parking areas and Tour Road pull-offs, both existing and proposed, should have filter strips associated with them. It is also important to mitigate run-off from large areas of paving, such as the main parking area at the visitor center; and the planned equestrian parking and staging area, which will present the added issue of animal waste run-off.

Filter strips should also be added along any waterways, drainages, and slopes that edge open areas where crop field exhibits are implemented. The extent will depend on the alternative selected by the park for crop field exhibits (see crop field exhibit project description). Filter strips would be implemented at crop exhibits at one or more of the following locations: Ray cornfield, Ray House area, Sharp stubble field and cornfield, and/or Gibson oat field.

Recommendations

Identification and Evaluation

- Conduct site visits and field surveys, using NPS natural resource specialists, to determine necessary buffer widths and placement.

Considerations

Factors impacting filter strip effectiveness:

— shallow, uniform flow is more effective for filtering run-off flow than concentrated flow conditions;

— the first 8 to 12 feet of the strip is the most effective in removing sand- and silt-sized particles of sediment (filter must be wider to effectively trap clay-sized particles);

— the strip becomes most effective when its width, location, and vegetation are matched to the soil, slope and drainage conditions at the specific site;

— the strip becomes less effective as the cropland area drained through the vegetated area is increased;

— the strip also becomes less effective when the depth of flowing water moving through it is greater than the height of the vegetation in the filter. Vegetation tends to lie over, which may help protect the filter strip area from erosion, but filtering efficiency decreases dramatically;

— the strip becomes less effective as sediment and nutrients build up in the vegetation;

— it is also less effective in trapping sediment and nutrients if run-off events occur very frequently with little or no rest or growth period between events;

—finally, the strip is less effective when not adequately maintained.

Existing Filter Strips:

- Assess the condition and effectiveness of existing grass filter strips adjacent to the Ray cornfield and Sharp's cropfield vegetation and rehabilitate as necessary using BMPs for agriculture if the buffer is not stable (for example, if vegetation is in poor health, there are numerous invasive plants, or the existing buffer is too narrow). Remove invasive plants using the guidelines provided in this document.

- Seed with native warm season grasses as needed.

- Consider filter strip conservation as part of all park landscape management planning and implementation strategies.

New Filter Strips

- Locate and install filter strips.

- Determine whether a filter strip is appropriate given the interpretive goals for the area, as well as park management objectives after delineating the buffer.

Implementation

- Examine current site conditions to determine species to be seeded considering the following elements:
  - — soil characteristics
  - — slope of land
  - — shape and area of the field draining to the filter strip
  - — hydrology
  - — type and condition of existing vegetation
  - — land use history
  - — location of cultural and archeological features
- Prepare the area for filter strip establishment by removing invasive vegetation and refuse, and protecting sensitive natural and cultural resources. Refer to guidance provided elsewhere in this chapter regarding control of invasive plants.
- Plant vegetation that is native within local riparian zones. Ecologists and plant specialists should determine the species compositions, the densities that will be required, and the appropriate season for planting.
- Monitor post-installation site conditions for seed germination and growth of invasive plant species.
- To maintain filter strips:
  - — Inspect regularly, especially after heavy precipitation events;
  - — Remove accumulated sediment periodically;
  - — Repair and reseed bare spots and areas where erosion channels begin to form;
  - — Mow vegetation to a 6-inch height 2-3 times per year, or burn, and remove woody vegetation and weeds; and
  - — Test soil periodically to assure continued plant health.
- Maintain filter grasses through infrequent mowing or prescribed burning.
- Avoid use of fertilizers and pesticides in the filter strip areas.
- Design filter strips to be at least 10 to 25 feet wide, depending on the slope of the field; steeper slopes require wider filter strips.

- Keep drainage areas relatively small, with no more than 30 acres of field draining to 1 acre of filter. In the case of impervious surfaces or intensive uses such as parking areas, the ratio should be smaller.

8. Reestablish critical views associated with the Battle of Wilson's Creek

Introduction

Reestablishment of critical views associated with Civil War landscape conditions is recommended to support the interpretation of the Battle of Wilson's Creek. While this may be accomplished through woodland thinning in the short term, it is recommended that the park reevaluate the quality of key views after savanna and prairie rehabilitation projects have been implemented. This will result in the reduction of woody thickets that are currently obscuring views. Where views are particularly critical to interpreting the events of the 1861 battle, proceed with clearing and thinning operations prior to vegetation community rehabilitation to establish these view corridors as soon as possible.

Location of Project

The key locations for thinning include views from the Ray House towards Wilson's Creek, views across Wilson's Creek between the opposing Confederate and Federal artillery positions, views from the Pulaski battery site, and views from Sigel's first and second positions.

Recommendations

Implementation

The woodland thinning techniques recommended here are intended to render the terrain more visually accessible without removing the majority of the existing vegetation.

- Engage an archeologist, natural resource specialist, and historical landscape architect to field-check the areas to be cleared and ensure that no cultural or natural resources will be adversely affected prior to removal of woodland vegetation.

- Follow BMPs for vegetation removal and thinning.

- Perform work in phases to ensure that the minimum amount of vegetation possible is removed to meet interpretive needs:

  — Phase One: Begin by removing invasive vegetation and trees that are diseased, unhealthy, pose a threat to visitors, or are a windthrow hazard. Remove the majority of saplings and shrubs. Prune and remove branches up to 15 feet above the ground.

  — Phase Two: Evaluate success of Phase One thinning operations. Further enhance visibility as needed by selectively thinning additional trees. Continue to remove invasive and diseased vegetation.

  — Phase Three: Evaluate success of Phase One and Two thinning operations. If the viewshed remains obscured, continue to selectively thin trees until the viewshed meets interpretive needs. As woodland is opened, seed with relatively shade-tolerant native grasses to prevent soil erosion and the establishment of unwanted opportunistic and invasive species. Maintain understory grasses by mowing periodically with a string trimmer; avoid contact with trunks of trees and shrubs to remain. Also thin the woody cover on a periodic basis as needed to maintain visual access.

- Avoid vegetation clearing or thinning in sensitive remnant and glade communities. Instead, follow glade rehabilitation recommendations outlined earlier in this chapter.

Woodland clearing recommendations

By law, any landscape management activity that moves, breaks, or disturbs soil requires some level of Section 106 and/or NEPA compliance before activities can begin. The compliance process must be completed before any ground disturbing activity can occur.

Park personnel should prioritize areas to be cleared, and work with botanists/ecologists to perform the environmental impact assessments. All potential cultural and natural resource impacts should be evaluated before determining which sites will be cleared. Once woodlands have been approved for clearing, park maintenance staff should be trained to undertake the monitoring process, manage invasive plant growth and soil erosion, and plant warm season grass cover.

The following criteria should be considered when weighing the decision to clear woodland:

— The area to be cleared should be located along or visible from one of the existing or proposed primary interpretive routes.

— Historic fields that are known to have played an important role in the battle and are visible from the interpretive tour route should have higher restoration priority than those that fall outside the tour route viewshed.

— Reestablishing a historic field should not result in open views to areas outside the park that would have a negative effect on interpreting the historic scene. This can be mitigated by ensuring a 100-foot-wide forest buffer is maintained along the perimeter of the park boundary.

The forests identified for clearing should be evaluated to ensure that there are no federal or state threatened, endangered, or rare species present, or rare habitats that are likely to support such species. The park should conduct the necessary surveys to determine whether these species exist prior to any type of forest clearing or thinning project. If endangered or threatened plant or wildlife species are identified, recommendations that may alter their habitats should be reevaluated prior to undertaking any woodland thinning or clearing. The following guidelines also apply:

— Do not perform clearing within wetlands and other sensitive ecological areas. Park wetlands should be delineated before field clearing begins. All federal, state, and local laws associated with wetlands or other sensitive ecological areas should be considered in the evaluation.

— Avoid clearing within the 100-foot-wide riparian forest buffer associated with Wilson's Creek.

— Avoid clearing existing woodland in areas with slopes that are steeper than 15 percent, and on soils that are classified as highly erodible or stony, although removal of invasive species should be undertaken in as many areas as possible.

The following economic and environmental costs should be considered when weighing interpretive benefits:

— Will the clearing result in a loss of wildlife habitat and further fragmentation of wildlife habitat in a quickly developing suburban area?

— Will the improvement to environmental health offered by the removal of invasives offset the environmental costs of tree removal? In areas where native species are crowded out, soil erosion is prominent, and wildlife have limited native habitat, a healthy stand of native grasses may be an ecological improvement. Severely infested wetland areas should be similarly evaluated.

— How much can the loss of topsoil and reduction in water quality, due to increased run-off during clearing and for a period of time afterwards, be mitigated?

— How much can the loss or damage of archeological resources, due to clearing, stump removal, and seedbed preparation, be mitigated?

— What is the financial cost of meeting Section 106 compliance in testing, collecting, and inventorying environmental and archeological resources?

— What is the financial cost of monitoring by specialists during clearing?

— What is the financial cost of managing new fields by mowing and/or prescribed fire?

— What is the financial cost of establishing native grass field cover?

— Can the costs of clearing be offset by the sale of the timber harvested?

Two options exist for woodland clearing: clear-cutting and gradual removal of the overstory vegetation. The selection of the most appropriate method for each field should be based upon considerations of cost, time, and other factors as described below:

Clear-Cutting

Although clear-cutting is generally recognized as the quickest and most efficient method of removing forest, the following must be taken into consideration:

- Clear-cutting should only occur where there are no remnant plant communities, and heavy equipment should only be used within very restrictive parameters.

- Such a drastic change in appearance, or views of a clear-cut, may disturb visitors.

- Clear-cutting may expose sensitive vegetation, such as historic trees, that had previously been protected by surrounding woodland.

- Adventive species may become opportunistic within surrounding woodland stands.

- Clear-cutting is a more expensive option than gradual thinning and removal of vegetation. Heavier machinery, increased labor, and stump removal raise costs.

Thinning and Gradual Removal

Thinning and gradual removal of overstory vegetation is a lower-impact method of tree removal. Issues relating to this method include:

- The process may take 5-10 years to completely remove woodland, and reestablish an open field.
- The method will likely have less impact on the surrounding woodlands and environment.
- It will be a less dramatic change for visitors.
- Continual maintenance and removal labor will be needed. A management plan for removal may be required to adequately address issues involved with this type of tree removal.

After a field has been identified as suitable for clearing, the following steps are recommended:

— Perform archeological testing of the site by a qualified archeologist.

— Conduct archeological and cultural landscape analyses within areas identified as potential archeological resources including, but not limited to, road traces, prior to forestry or clearing/grading operations. Allow forest to remain where archeological resources exist with integrity in unplowed contexts.

— Prior to clearing woody growth, consider carefully the proper locations for establishing sight lines that are consistent with 1861 military events.

— Prior to clearing, field check clearing locations with an archeologist, natural resource specialist, and historical landscape architect to ensure that natural or cultural resources will not be adversely affected.

— Retain existing woodlands, allow woodlands to grow up, or plant woodlands along the park perimeter to maintain a visual buffer. Buffers should consist of mixed species woodland with understory plants, and should be a minimum of 100 feet in width. Promote varied plant composition, and consider locally native woodland species for buffer plantings.

— Incorporate silvicultural methods that minimize the impacts and threats to cultural and natural resources and known and potential archeological resources. Undertake forest harvesting monitored by a historical landscape architect and archeologist.

— Manage timber harvesting operations to protect environmental resources, reduce clearing costs, and maximize income to the NPS from any marketable timber by employing the steps included in the three categories listed below:

  - Pre–harvest planning: Delineate the actual boundary of the site to be cleared using an interdisciplinary team, including a historian, archeologist, historical landscape

architect, forester, soil scientist, and wildlife biologist. The team should collectively delineate the locations and alignments of all timber haul roads, loading areas, stream-side management zones, and other related conditions of the harvest. The forester should then inventory the woodland to be harvested and recommend the provisions to be included in the timber sale contract.

- Timber harvest administration: The forester's responsibilities should include regular inspections of the harvesting operation to monitor compliance with the terms of the contract and applicable laws. The archeologist, soil scientist, and/or other professionals may also participate in these inspections.

- Site Restoration: Adoption of BMPs to protect resources should be an ongoing provision of the harvesting contract. At completion of the harvest, final BMP installation and maintenance should be performed by the timber buyer, subject to the approval of the forester. Appropriate BMPs and erosion control measures should be included in the contract. The new fields should be planted with native warm season grasses. Information contained within this report should be used to guide native grass establishment; however, vegetation experts should be consulted to ensure the success of new grasses.

- Work should be conducted by a tree removal service with successful experience working at historically significant sites.

— Treat stumps and sprouts with a systemic herbicide to discourage and control regeneration. Control of woody plant regeneration through chemical means should be conducted by a certified herbicide applicator—either qualified park staff, or a landscape contractor.

— Cut stumps; do not uproot them. Remove by using a stump grinder. Test the perimeter for archeological resources before grinding stumps.

— Perform cutting or thinning in the fall and winter. Fewer visitors are at the park, dormant trees are less likely to be damaged, there are no nesting birds or animals in the vegetation, and sufficient time would be available to remove ground vegetation before spring growth.

— Minimize the use of heavy vehicles; restrict use to times when soil is firm.

— Remove felled trees without dragging, which gouges the ground surface.

— Employ measures to stabilize soil and minimize erosion.

— Minimize disturbance to the surface when planting new cover.

— Consider, where forest clearing is not feasible or desirable, thinning the forest understory and removing the lower branches of forest trees to permit views in key interpretive areas where the landscape would have been open in 1861 (see viewshed reestablishment recommendations listed earlier in this chapter). Avoid sensitive ecological areas in implementing this recommendation.

— Establish native grass and forb cover over areas that have undergone forest clearing.

9. Establish new trails to provide access to interpreted sites and resources

Introduction

This CLR recommends the establishment of new trail segments that allow for a series of pedestrian loops, initiating from parking pull-offs along the Tour Road, to provide access to features of the 1861 cultural landscape and the locations of important events associated with the 1861 battle. Many of these loops incorporate existing pedestrian trails into a larger system, but there are also many proposed new trail segments that follow historic roads or road traces.

Location of Projects

Trail 1 begins at the Gibson oatfield pull-off and follows the historic fenceline and adjacent road system to the mill and house site. Along the way, troop movements through the Ray cornfield are interpreted through new vegetation management and mowing practices. The Gibson property and associated industrial activities would also be interpreted. A creek crossing leads to the hill above the creek, which the Union army used for its advance and withdrawal from the battle. The trail leads past the Short springbox. A spur trail leads to a contemplative node at the Short House site. It is possible to also follow a connected spur to the Bloody Hill trail, which provides interpretation of Lyon's advance route from the vicinity of the Short House. The main trail follows the Tour Road back to pull-off 1, and additional interpretive opportunities are provided as part of a pedestrian system. Battle events that might be interpreted along the route: the encampment of Cawthorn's mounted brigade, Rains' headquarters, Plummer's lines of advance and retreat; Hunter's Confederate retreat in the face of Lyon's Union advance; the Short House and springbox.

Trail 2 is comprised of the existing Ray House and springhouse trail segments. The Ray orchard would be interpreted through a new exhibit. McIntosh's attack, and the use of the Ray House as a hospital and later to lay out General Lyon's body, might be interpreted along the trail segments. Establish a new trail segment as part of Trail 2 that connects the Ray springhouse with the Ray cornfield, providing interpretation regarding the battle events associated with the field.

Trail 3 initiates at pull-off 3 along the Tour Road. It incorporates the existing trail leading to the Pulaski Arkansas Battery site; the Guinn homestead and orchard are interpreted as part of this trail system. A new segment arises along the Wire Road at the base of the knoll where the battery site is located. This segment leads to the C.B. Manley House site along a historic road trace, then follows a stream corridor and returns to the parking pull-off along the banks along Wilson's Creek where the trail interprets the locations of the Confederate camp prior to the battle. An interpretive exhibit illustrating the house precinct of the C.B. Manley House would be established. Battle events that might be interpreted along the trail include the site of McCulloch's headquarters, Pulaski battery site, Bledsoe's battery position, Weightman's line of march, the Fort Smith artillery position, Confederate encampments along the creek, Arkansas battalion movements, Wilson's Creek ford, and the Wire Road. This trail could also interpret the former Town of Wilson Creek.

Trail 4 arises at parking pull-off 4. It travels along the creek to a crossing and spur trail leading to the site of Backoff's battery. The site of Sigel's first position might also be interpreted visually from this trail, although the trail itself would not extend all the way to the position. Visitors would then retrace their steps along the spur to traverse a new trail segment leading through Sharp's stubble field where Confederate encampment, troop movements associated with the First Arkansas, and Sigel's second position might be interpreted. The trail would lead to the western edge of the

park and connect with the Wire Road. Along the way, the location of a road that existed at the time of the battle would be marked through mowing patterns, and lead south towards Terrell Creek. The trail would follow the Wire Road to the Tour Road interpreting the approach route taken by various Confederate battalions. The Osage orange fence edging the Wire Road could also be interpreted. The trail would thereafter follow the Tour Road back to the pull-off, providing interpretive information about the Sharp farmstead and the battle events associated with it.

Trail 5 incorporates Bloody Hill and the slopes to its east. It begins at the parking pull-off for Bloody Hill and includes the existing trail leading to the sinkhole and the Lyon Marker. A new trail segment is recommended leading east from the marker that avoid traversing the nearby glade habitat. The recommended trail leads south, skirting the glade, and eventually following the route of a historic road that was present at the time of the battle. The trail would lead east to the Wire Road and Wilson's Creek. A network of other roads also existed in this area at the time of the battle. These would be interpreted in a fashion similar to the road edging Sharp's corn and stubble fields—by mowing patterns through the grasslands that characterize this portion of the site. Along the trail, various battle events might be interpreted, including early clashes between Lyon's troops and various Confederate battalions, the attack by Price's troops that led to Union retreat, and use of the Edwards cabin as a hospital. The trail would return to the parking pull-off along the Tour Road, providing interpretation associated with Guibor's battery, and the route taken by General Pearce's Arkansans and their attack on the Union right.

Recommendations

Implementation

- Prepare a park-wide trail management plan to establish standards for existing and proposed trails, and to delineate issues such as: the need for new trails; how to handle existing trails or trails that will be taken out of use; the appropriate location, materials, and design of new trails; and levels of accessibility.

  — Incorporate loops of different lengths when possible to provide a varied visitor experience.

  — Consider using soil cement or crushed stone as a surface material. Avoid paving in asphalt or concrete unless necessary for universal accessibility; consider crushed stone, which is acceptable as a universally accessible material if maintained properly, as an alternative to asphalt or concrete paving.

  — Clear vegetation adjacent to accessible trails to a width and height of 8 feet. Maintain a 5- to 6-foot-wide treadway free of obstacles on a two-way trail. Widened passing nodes at regular intervals along the trail can be utilized in conjunction with narrower trail widths. Establish defined edges along the trail, and consider providing guide ropes for the visually challenged. Avoid exceeding a 5 percent grade. Provide regular rest stops on slopes. Provide at least 3 feet of level, cleared space at the side of benches for wheelchairs, and take into consideration wheelchair maneuverability when designing scenic overlooks and contemplative nodes.

  — Designate trails that are not designed to accommodate universal accessibility as "natural." Maintain a 3- to 4-foot wide prism on natural trail segments. Provide alternative interpretive opportunities in accessible locations for those persons who cannot use the trail.

- Retain existing trail routes as indicated. Repair and maintain these in accordance with the proposed Trail Management Plan (not completed at the time this document was prepared).

- Establish new trails taking into consideration the proposed routes, interpretive planning, and site condition evaluation to determine features to avoid, such as slopes, potential archeological resources, and sensitive natural resources.

- Avoid constructing the trail prism across known archeological sites.

- Avoid constructing trail prisms through remnant glade or savanna communities.

- Surface accessible interpretive loop trails in crushed aggregate brownstone. Other trails not intended to support primary battlefield interpretation should be surfaced with hard-packed earth, stabilized with soil cement if necessary, and only minimally graded.

- Provide a firm and reliable trail prism within wet areas, using minimal and unobtrusive construction techniques. On heavily used or universally accessible trails, use low-profile wooden boardwalks, bridges, or culverts. On trails that are designated as natural, use locally collected or quarried stepping stones or a rock treadway.

- Incorporate native stone as much as possible into trail-related structures including water bars, stepping stones, steps, treads, stream crossings, stone boxes or treadways crossing marshy areas, and trail markers, taking into consideration the park's need for a standard design guide. Design these features to clearly be a product of their time.

- Follow the Uniform Federal Accessibility Standard (UFAS) and Americans with Disabilities Act Accessibility Guidelines (ADAAG) regulations for trails and path as much as practicable. Avoid steep cross or running slopes, ensure that trail widths meet regulations, and take other precautions to make trails accessible to all visitors.

- Stake the trails on site to best accommodate the variable topography, streams, and other conditions. Follow the park's trail management plan for design guidance.

- Consider carefully the alignment of trails to establish the minimum number and least-intrusive bridges and boardwalks necessary. Establishment of loop trails will require at least two bridge or ford structures to cross Wilson's Creek. Assess the environmental impact of establishing new bridges within the park to establish the trails. Consider means for crossing the creek that involve the least possible impact to water or other natural resources. Alternate trail routes must be designated if water bodies are expected to be adversely impacted.

- Consider the following options where new trails overlay historic road traces:

  — Consider placing sections of the trail along the road trace if it is highly discernible, intact, and can serve as an interpretive tool. This placement will provide visitors with the experience of following the exact route of the historic circulation corridor. Prior to construction, engage an archeologist to conduct on-site investigations to determine any potential impact on cultural resources. Parallel historic trace roads that cannot sustain adaptive reuse with a pedestrian trail system without degrading.

  — Consider locating new trails to follow the routes of historic traces based upon mapping if the road trace is no longer evident. Use historic maps and photographs to locate the

trails in alignment with historic routes. Prior to construction, engage an archeologist to conduct on-site investigations to determine any potential impact on cultural resources.

10. Interpret missing 1861 farmsteads

Introduction

The Ray House is the only substantially developed interpretive stop on the tour route that interprets the nineteenth-century farmstead to visitors. The house contributes to the 1861 battle period and serves to represent the numerous other farmsteads that were present during the battle. The Ray farmstead provides the best opportunity for interpreting the historic character of the 1861 landscape; no others within the park depict as fully the domestic and agricultural nature of the battle landscape. Located along the Tour Road, the Ray House is frequented by many visitors.

Other former farmstead sites lie along the Tour Road and throughout the park, however. Interpretation of these sites is critical for understanding the character of the landscape at the time of the battle. The interpretive potential of these sites is presently not fully realized. The majority of the features that comprised the 1861 cultural or built landscape, such as houses, outbuildings, fences, crop fields, and orchards, are missing, making it difficult for visitors to envision the 1861 landscape that soldiers experienced.

The primary treatment concept for these former farmstead sites is the preservation, protection, and repair of existing historic structures and fabric, in conjunction with the establishment of exhibits representing selected aspects of the 1861 landscape. A more accurate depiction of the historic character will greatly improve interpretation at these sites and in the park as a whole. Representations of missing structures at the farmstead sites, combined with reestablishment of cultural vegetation, offers the most feasible and effective treatment for improving the interpretation of historic character.

Project Location

The project would encompass many of the areas where farmsteads were located in 1861 at Wilson's Creek. These areas include the Ray, Guinn, Sharp, C.B. Manley, E.B. Short, and Gibson sites.

Recommendations

Implementation

- Consider interpreting the locations of ruins and missing outbuildings through various means, using physical and documentary information, including (listed in order of increasing accuracy/complexity):

  — Markers: When locations of missing structures are known, but overall dimensions have yet to be determined, consider installing metal signs or medallions in the ground that visually communicate the physical dimensions of the site and depict patterns of spatial organization. These may be coordinated with an interpretive wayside that graphically depicts an artist's rendering of the missing feature during the time of the battle and bring life to the historic scene. Convey to the visitor the role of interpretation in understanding missing features.

— Foundation outlines: When the dimensions and location of the footprint of a missing building or structure are known, an outline or other demarcation such as low walls or corner markers can be placed on the ground to aid interpretation. If footings are necessary, avoid digging into the ground, instead adding a minimal layer of fill over the site to protect any archeological resources. A foundation outline can be constructed of typical local building materials. However, the foundation outline should clearly be of a product of its own time, so that it can be distinguished from surviving historic foundations or ruins.

— Ghost structures: When the overall dimensions, roofline, and massing of a missing building or structure are known, consider developing a three-dimensional ghost structure on the site.

- Reestablish the historic fencing configuration associated with each of the farmsteads, if known. Fences are strong visual aids for interpretation, depicting historic spatial organization and property ownership. Post and rail fencing is known to have been located around some crop fields, such as the Ray and Sharp cornfields. The Hoelcke and Boardman battlefield maps show some fencing, and eyewitness accounts from 1861 describe them to some degree; however, there is insufficient information to accurately portray nineteenth-century fencing. Additional research will be necessary to verify the character, types, and locations of fences. Currently, wooden worm fencing is used in some areas where no fencing was present historically, such as pull-offs, that relate to contemporary park management and maintenance requirements. The result is an inaccurate historic picture inferring that these contemporary features (using historic forms) were part of the historic landscape. Replacing fencing in these areas with contemporary, but compatible, fence types and reestablishing historic fence types where they occurred in 1861 would correct this false picture and improve visitor understanding. Consider the following guidelines in developing fence rehabilitation:

  — Inventory and map current fence locations and types.

  — Use available documentary and physical evidence to determine which existing fences correspond to historic fence locations and which are located in areas where fences did not exist.

  — Replace historic fence types used in contemporary locations with contemporary but compatible fencing types and materials.

  — Design new fencing as a product of its time and compatible with the historic resources in materials, size, scale, proportion, and massing, while maintaining a clear differentiation between the historic and contemporary fencing.

  — Consider the visual impact of new fence design—contemporary fencing should be functional but not detract from the historic setting or views. In some areas, alternatives to fencing, including bollards, low edging materials, boulders, or vegetation might be effective and less intrusive.

- Consider reestablishing historic fence patterns in certain areas in conjunction with the removal of any historic fence types in non-historic locations. Areas best suited for

reestablishing 1861 fence patterns are the Ray, Sharp, and Gibson fields; the Ray and Guinn orchards; and the C.B. Manley and Guinn house precincts.

— Ensure that the reestablishment of 1861 fence patterns conforms to the historic fencing type based on functional and accurate location (post and rail fencing around selected crop fields based on historical evidence); material (wood); and construction method (as discussed above).

- Alter vegetation management regimes within the farmstead areas, such as varying mowing schedules and grass species, in such a way as to yield a diversity of appearances (i.e. cut grass in farmyard areas more frequently than in areas of pasture or crop fields).

- Reestablish the historic orchards at the Ray and Guinn farmsteads.

- Reestablish crop field exhibits at one or more of these sites.

- Supplement existing interpretive media and programs with new materials to enhance the depiction of the life and work of the inhabitants of the area when the battle began. Locate new interpretive media in an unobtrusive manner to avoid detracting from the historic scene.

Consider the following alternatives for the different farmstead sites at Wilson's Creek:

- Ray House, springhouse, and farm:

  — Consider interpreting the Ray House as one of the earliest remaining settlement dwellings in the Springfield area.

  — Incorporate a new orchard exhibit in association with the Ray House property to depict the orchard present at the time of the battle.

- Site of Gibson's Mill, house, and associated bottomland crop fields:

  — Consider interpreting the missing mill and house.

  — Interpret the former oatfield fence and road that paralleled the fence.

  — Replace the existing trail with a new trail that follows the historic road alignment.

  — Provide a bridge crossing of Wilson's Creek to extend the trail in the location of a former road crossing.

  — Plant the former Gibson cropfield either partially in crops such as oats, with a vegetative filter strip to protect wet areas, or entirely in warm season grasses. Where 1861 crop field boundaries come within 100 feet of the edge of Wilson's Creek, utilize low-growing riparian plants within the area to maintain a vegetative filter strip. Ensure field management is undertaken in keeping with the Water Resources Protection Overlay Zone, while at the same time maintaining a sense of the fields' 1861 spatial organization.

- Sharp farmstead site and crop fields:

  — Interpret the Sharp farmstead site by establishing a new exhibit with a pull-off and interpretive materials.

  — Plant the former Sharp cornfield in warm season grasses. Plant the Sharp stubble field in warm season grasses also, and consider mowing this field each year in late July to replicate the feeling of the cut cornstalks that were present at the time of the battle in August 1861.

  — Interpret Sigel's second position along a trail through the field.

  — Interpret the Sharp field fences.

  — Interpret the route of a former road that paralleled the Sharp field fencing to its west.

- Guinn property:

  — Interpret the site of the Pulaski Arkansas battery, including the former Guinn house that was utilized as a headquarters during the battle.

  — Incorporate a new orchard, fencing, and house precinct exhibit to depict the former Guinn farmstead. The house sat within a small, fenced lot adjacent to a small, fenced orchard on the slope to its northwest.

- C.B. Manley, and E.B. Short farmsteads:

  — Interpret the use of this property during the battle, and establish an interpretive exhibit depicting the former Guinn House and fenced precinct that was utilized as a headquarters during the battle.

- Consider these alternatives for the Edwards farmstead:

Alternative 1

  — Remove the cabin based on the fact that is was relocated into the park from another property. Interpret the site of the missing Edwards Cabin through alternative means.

Alternative 2

  — Retain the cabin *in situ*. Remove the plywood and metal sheathing and treat it like an exhibit that illustrates a feature with similar historic properties as the original cabin. Clearly indicate to visitors that the existing cabin is not an accurate representation of historic conditions.

11. Establish crop field exhibits in limited locations

Introduction

This project addresses the establishment of historic crop field exhibits at Wilson's Creek. The Ray House, Sharp House, Gibson House and Mill, and other farmsteads that existed within the Wilson's Creek area in 1861 had several known crop fields associated with them, with corn and oats being two major crops mentioned in accounts of the battle. Reestablishment of limited areas of crop planting would greatly enhance the interpretation of these farmsteads and their agricultural and domestic nature, as well as the character and complexity of the agricultural landscape at the time of the battle.

The fertile lands associated with the Wilson's Creek corridor were historically cropped, beginning in the early settlement period and continuing through much of the twentieth century. The areas of the Ray cornfield, Gibson oatfield, and Sharp stubble field and cornfield lend themselves to possible exhibits of historic cropping. For example, within the viewshed of the Ray House, and proximate to it, crop fields may be used to interpret the 1861 appearance of the site. Crops would include historically appropriate species and varieties as identified during further research.

Cropping will be carried out using NPS BMPs to ensure environmental sustainability. Reestablishing a portion of this cropland will support an important understanding of the historic scene. By planting in locations historically utilized for crop fields, only previously disturbed sites will be used, limiting the potentially negative effects on the ecosystem; other former field areas are to be planted in native warm season grasses.

Location of Project

This project would take place at one or more of the following: the Ray cornfield, Sharp stubble field and cornfield, and/or Gibson oatfield.

Recommendations

Implementation

- Base locations of crop field exhibits on historic documentation for the area from the 1861 period, and additional documentation specific to the farm fields being considered (1860/1870 census, deed descriptions, tax maps, etc.).

- Select crop species based on historical accuracy and on documentary or physical evidence (e.g. archeology). Also consider varieties that were historically grown in the area. Consider varieties of corn, oats, and other crops noted in accounts of the 1861 landscape. Consider, when collecting archeological data, conducting pollen analysis to determine possible historic crops planted in the area.

- Species should be limited to those causing the least deleterious impact on the environment. If substitution is necessary, select crops that have similar heights, colors, textures, and planting patterns to the historic crop cover.

- Consider the appearance of the fields shown in historic depictions in designing crop field exhibits. Also refer to agricultural census data and any available information included in records and diaries.

- Employ the NPS draft document "Managing Culturally Significant Agricultural Landscapes in the National Park System," by Richard Westmacott, in designing crop exhibits.

- Make every effort to cultivate the crops in a manner that is consistent with the practices of the period, if feasible.

- Consider modifying historically accurate methods when sustainability concerns arise. Utilize sustainable, low-impact maintenance practices, integrated pest management, and other BMPs in establishing and maintaining these exhibits. Interpret modifications of historic farming practices to educate visitors about sustainability.

- Avoid no-till methods for crop farming in exhibit areas, as no-till is a contemporary method that creates an appearance that is not consistent with farming at Wilson's Creek during the period of significance. In addition, it requires heavy use of chemical herbicides and fertilizers.

- Promote sustainability by avoiding the use of chemical additives such as pesticides, herbicides, and chemical fertilizers as much as possible. Interpret these possible deviations from past practices, and encourage similar stewardship.

- Avoid planting crops on slopes of 10 percent or greater.

- Examine proposed sites for potential archeological resources and evaluate their susceptibility to damage from activity prior to any implementation.

- Avoid planting crops that are considered invasive alien or noxious weed species in Missouri. Establish guidelines for site access by farm equipment that ensure invasive species' seed germ is not brought on site; for example, require cleaning or washing of the equipment off site. Consider planting crop field exhibits that illustrate the range of agricultural endeavors that occurred on the interpreted farmsteads in 1861.

- Rotate crops based on historically accurate practices. Use crop rotation as part of a program to control weeds and pests and prevent depletion of nutrients from the soil.

- Consider methods for crop irrigation that are consistent with historic practices.

- Establish or maintain buffers of natural vegetation between crop fields and perennial watercourses.

Consider a range of alternatives for interpreting former crop fields:

Alternative 1: While it would be ideal to reestablish the entire extent of historic cultivated fields, labor, capital, and environmental constraints will likely make this option prohibitive. Consider phasing crop field reestablishment, or implementing it partially to maximize interpretive value by creating a limited crop exhibit. Prioritize crop field locations as follows: first, a selected area in the viewshed of the Ray House, where it would have a strong interpretive impact; second, areas of Ray

or Sharp fields along roads and in viewsheds of visitor areas; and third, the Gibson oatfield and other areas closer to the creek and away from immediate visitor contact. Use interpretive signage or living history demonstrations to educate visitors about the former extent of the fields, historic cultivation techniques, and the role of the agricultural fields in the battle.

Alternative 2: Plant different crop fields in all historically documented locations, such as the Ray cornfield and the Sharp stubble field and cornfield.

Alternative 3: Establish warm season grass fields, instead of replanting crops, to interpret crop fields associated with local farmsteads at the time of the battle. Utilize creative means to depict historic patterns representative of crop fields, such as mowing patterns, or the planting of different grass species in linear strips reminiscent of crop rows. Use interpretive signage or living history demonstrations to educate visitors about the former extent of the fields, historic cultivation techniques, and the role of the agricultural fields in the battle.

12. Establish orchard exhibits in limited locations

Introduction

According to historic maps, at least two orchards existed within the area associated with the Battle of Wilson's Creek. These were located within the Ray and Guinn farmsteads. Orchard exhibits at these sites will enhance interpretation of the character of the battlefield and associated farm life in 1861.

One of the most important considerations in the selection of appropriate tree species for reestablishing orchards will be the ability and willingness of park staff to maintain the trees. Non-historic species are available that would approximate 1861 conditions. Interpreting the orchard as an exhibit that may not accurately reflect 1861 historic conditions is another alternative. Sustainability is an important consideration.

Location of Project

Nineteenth-century maps indicate that there were orchards southwest of the Ray House and southeast of the Guinn House at the time of the battle.

Recommendations

Implementation

One of the most important considerations in the establishment of orchard exhibits is the selection of appropriate tree species; maintenance of orchard trees can be labor intensive and time consuming, and many species require application of chemicals (such as pesticides) that are antithetical to NPS sustainability initiatives. If trees are not maintained, their health and therefore effectiveness as interpretive features will be limited. Selection of historic cultivars may require more maintenance than park personnel can provide. Alternative species are available that would approximate 1861 conditions.

Although it is not possible to infer from historic maps what species were used in the orchards, it is likely that they included apple trees. While further research may reveal additional information about the orchards, this research is beyond the scope of this project. Agricultural census data and personal records of individual property owners and residents may indicate the types and numbers of fruit trees grown in the area. However, it remains highly possible that specific information about the exact species and cultivars will never be located. Unless such information is located, reestablished orchards should be treated as exhibits and interpreted as such. Cultivars and/or species that were typically used for orchards in the region during the period can be selected to support interpretation (see below). It is also possible to select contemporary orchard tree species that require minimal maintenance. Species selection for the exhibit orchards should take into consideration the amount of labor available to care for these trees.

Consider the following guidelines and recommendations in planning for implementing orchard exhibits.

— Select apples for orchard planting based on a balance between historical value, hardiness/disease resistance, and maintenance capabilities.

— Consider opportunities presented by orchard planting for conservation of old apple varieties, particularly those originating or typically grown during the mid-nineteenth century in Missouri.

— Consider the role and benefits of orchards for wildlife, especially birds.

— Consider working with local apple growers in a partnership, perhaps providing graft material from old varieties for their use, in exchange for their assistance with care of the trees.

— Select at least two varieties of apples if fruit production is desired to ensure cross-pollination required for fruiting. Consider using a mix, including a disease-resistant modern variety and a historic variety.

— When deciding on whether to use a variety of apple, historic or otherwise, consider hardiness, disease resistance, ease of replacement, and other maintenance issues. Choose a variety if possible that is not only historic, but also has characteristics that will ensure its success in growing within the park.

— Select a variety of apple that is tolerant of the heat and humidity that typically occurs during Missouri summers. Three alternative approaches are provided below.

Alternative 1

Select historical varieties known to have been grown in Missouri in 1861. Old Missouri varieties may include, among others: Oliver, Haas, Ingram, Missouri Pippin, Ozark Pippin, and Ralls Janet. Further research is required to located information on specific varieties grown in the Wilson's Creek area or in Christian and Greene Counties. Those that may have been grown in the area based on review of Lee Calhoun's *Old Southern Apples* include: [5]

Oliver (Senator, All-Over-Red Senator, Oliver's Red) is an early nineteenth-century Arkansas variety that appears to have originated on the farm of John Oliver, seven miles south of Lincoln in Washington County, Arkansas. It was first marketed by local nurseryman John Holt about 1850, and was grown in the Ozarks. Stark Brothers Nursery began in 1895 to sell this apple under the name 'Senator.' The skin of the Oliver apple is glossy, thick, red over green, and speckled white. It is a fall apple of medium size, and an excellent keeper. The tree is a vigorous, productive annual bearer, according to Calhoun.[6]

Haas (Fall Queen, Maryland Queen, Hoss) originated in St. Louis, Missouri in the 1800s. A very hardy American apple, it was most popular in the Midwest (west of the Mississippi and north of the Ohio River). The fruit is medium to large, with smooth yellow skin mottled with red; the flesh is white, sometimes stained with red. This apple ripens in September-October.

Ingram (Ingraham, Ingram's Seedling) originated in Missouri before 1855. This apple is medium to large with tough, red-streaked yellow skin and firm, white, juicy flesh. Ingram is a late bloomer, which protects it from late spring freezes; it ripens in October. It is thought to be a

[5] Creighton Lee Calhoun, Jr. *Old Southern Apples* (Blacksburg, VA: The McDonald & Woodward Publishing Company, 1995).
[6] Calhoun, *Old Southern Apples*, 115.

seedling of Ralls Janet. Ingram trees need thinning to prevent limb breakage and produce sizeable apples; the fruit is a good winter keeper and good for cider.

Missouri Pippin (Missouri Keeper, Missouri Orange, Stone's Eureka) was brought to Missouri by Brinkley Hornsby, a Johnson County settler, in 1839. Like many settlers, he brought seeds with him and planted them on his new homestead. It first fruited in 1854 and was subsequently propagated as nursery stock. It was popular as a commercial variety. This early-bearing apple fruits in its second or third year. It is susceptible to fireblight. Fruit is medium-large, round to conical, and flattened on the ends. The thick, smooth skin is greenish-yellow with red stripes. It ripens late, November to January, and is a good keeper.

Ozark Pippin (Deaderick, Ben Ford) originated in 1850 on the farm of Benjamin Ford in Washington County, Tennessee. It was rediscovered in 1992 in Tennessee under the name Ozark Pippin, Calhoun notes. Fruit is large, asymmetrical, and somewhat conical. The tough, smooth yellow skin has large reddish spots or blushing. It ripens in the fall and is a good keeper. This apple may be difficult to acquire, as Calhoun has no catalog information.

Ralls Janet (Neverfail, Jefferson Pippin, Royal Janette, and many other names) was first recorded in 1800 on the farm of Caleb Ralls in Amherst County, Virginia. Fruit is medium to large with thin greenish-yellow skin covered with pinkish red and overlaid with dark red striping. The yellowish flesh is fine-grained, crisp and juicy. Ripens in October and is an excellent keeper. Tending to bloom and leaf out late, this tree is heavy bearing, requiring careful thinning to ensure good fruit size. It is susceptible to fireblight and its twiggy habit requires annual pruning.

Alternative 2

Consider a contemporary variety that is grown successfully in the local area, is not a heavy fruiter, is immune or highly resistant to cedar apple rust and other diseases, and requires minimal maintenance. Cultivars that are highly resistant to cedar rust, a common apple disease which lives on Eastern redcedar (*Juniperus virginiana*)—of which there are many within the park—as its alternate host, are preferable. "Under rainy conditions in spring, gulls on the cedar branches produce orange, gelatinous horns that release spores. Wind can carry the spores as far as a mile to infect the young leaves and blossoms of apple trees. After infection, the orange-brown lesions appear on the upper sides of the foliage or on fruit. On susceptible varieties, cedar apple rust can cause defoliation and loss of fruit quality."[7] Some immune or resistant varieties include Redfree, Liberty, Jonafree, or Williams' Pride.

[7] Michele R. Warmund, "Disease-Resistant Apple Cultivars" in *Agricultural publication G6026* (Columbia, MO: University of Missouri, 1999), 1.

13. Provide new equestrian parking complex at the Visitor Center

Introduction

It is recommended that a new equestrian parking and staging area be constructed to the north of the Visitor Center complex along Route 182. The current location of the parking and staging area for horseback riding, west of the Ray House, is not associated with the park Visitor Center complex, and thus provides challenges for management and visitor orientation. Relocating this staging area closer to the Visitor Center will also expand the interpretive and recreational potential of the equestrian trail by providing opportunities for a continuous equestrian loop.

Location of project

The proposed equestrian parking and staging area is located to the north of the visitor center, between Route 182 and the Tour Road, near the location of the former wastewater treatment plant.

Recommendations

Implementation

- Provide the following facilities at the new equestrian parking area:
  - — Parking spaces sufficient in size to accommodate trucks with trailers:
    - o Generally these should be 45 feet long (35 feet to accommodate the trailer and an additional 10 feet for unloading the horses).
    - o Spaces should be 15 feet wide, which will allow horses to be tied to the trailer if necessary.
  - — Spaces adequate for car parking for equestrians arriving separately.
  - — Sufficient turning radii for trucks with horse trailers (30 feet).
  - — Clearly defined and marked entry/exit.
  - — Shaded staging area containing the following features:
    - o Hitching posts and rails to hang tack and feed.
    - o Mounting blocks.
    - o Water source.
    - o Minimum vertical clearance of 12 feet.
    - o Signage orienting equestrians to trail route, and outlining park regulations and trail etiquette.

— Vegetative filter strips to protect water quality from parking lot run-off and manure.

— Consider designing the parking lot so that horse trailers can pull out of the area without having to back up.

— Consider surfacing the parking area with softer and more pervious materials than asphalt, such as granular stone or like material.

14. Establish specific equestrian trail and access routes

Introduction

It is recommended that the existing Edgar Spur Trail be adapted for equestrian use, leading to a larger system of equestrian trails. New trail segments are proposed to expand the equestrian network. The current Ray Cornfield Trail is recommended for closure as it traverses the center of the Ray cornfield, which serves as a key interpretive feature. Closure of this trail will ensure vistas of continuous open field that are not disrupted by horses and riders. The new segment is proposed to avoid the cornfield and join the existing trail near the McElhaney House. Evaluation of existing equestrian trails slated for continued use is recommended to ensure safety for horses and riders.

Location of project

This system will begin at the new equestrian staging area near the Visitor Center, following the Edgar Spur Trail eastward across Wilson's Creek. A new trail segment is proposed to connect with the Edgar Spur north of the Edgar cemetery, crossing the Wire Road before linking up with the existing Manley Uplands Trail near the McElhaney House. The loop then utilizes the existing Southwest Boundary Trail to link to the Historic Wire Road Trail. South of the Ray House, near its intersection with the Tour Road, the trail backtracks along the new segment and the Edgar Spur Trail and returns to the equestrian staging area.

Recommendations

Implementation

Adapt the Edgar Spur Trail for shared equestrian/pedestrian use and construct new trails (realignment of Ray Cornfield Trail) based on the following:

- Maintain a cleared area that is, at a minimum, 12 feet in width and 12 feet high along the two-way trail and around the area where horses are unloaded and readied for trail rides.
- Provide bump-outs along the trail for pedestrians to use when stepping out of the way of horses.
- Maintain a forward sight distance of 100 feet where hikers share the trail.
- Avoid exceeding a slope of 10 percent along the trail, with resting grades of 4 percent or less for 500 foot lengths at regular intervals. Do not exceed a 4 percent cross-slope on the equestrian trail.
- Provide trail marker signage that identifies the trail as shared pedestrian/equestrian use.
- Close the existing Ray Cornfield Trail to equestrians by installing temporary bollards with informational signage explaining the interpretation objectives of the NPS and the new alignment. Allow the trail to be revegetated in accordance with the field reestablishment guidelines provided earlier in this chapter.

Guidelines for all equestrian trails within the battlefield (existing and proposed):

- Limit the size of groups using the trail at one time to 10, with a daily limit of 20 horses per mile per day (in accordance with the 1988 Trail Management Plan).
- Require horses to remain on designated trails to preserve vegetation and ensure visitor safety.
- Warn riders at least 200 feet in advance of vehicular road crossings and post adequate signage.
- Ensure that bridges are a minimum of 8 feet in width.
- Avoid allowing horses and bicycles to use the same trail.
- Restrict equestrians from using the Loop Road as much as possible.
- Minimize the number of trail access points.
- Avoid wet areas and steep slopes, both of which may present serious trail maintenance issues where regular equestrian use occurs.
- Keep crossings of water and roads to a minimum.
- Route equestrian access away from sensitive plant communities such as limestone glades, especially those containing endangered species such as Missouri bladderpod; and from caves that provide roosting habitat for the endangered gray bat.

15. Develop design guidelines for contemporary park features

Introduction

To facilitate the implementation of necessary new features and replacement of non-historic features lost due to condition issues, consider preparing a park-wide design guide. The guide would illustrate standards for new landscape features and systems to accommodate park visitor use, interpretation, management, and maintenance. Such features might include paths, walks, trails, road surfaces, parking and pull-off areas, contemporary fencing, site furnishings such as benches, and parking area features such as bollards, wheelstops, and curbing. The guide would identify products, materials, and dimensions for non-historic site furnishings, and include typical details and installation information. Use of the guide would enhance the park's identity, and serve to simplify the palette of materials within the park, which would in turn diminish the impact of non-historic features on the historic scene.

Recommendations

The design guide would be intended to augment NPS system-wide standards, with guidelines and standards specific to Wilson's Creek NB. Design of these features should be compatible with the rural, vernacular character of the battlefield, clearly a product of their own time, and as simple, sturdy, and unobtrusive as possible. Consider, as part of the design of these new features, attention to scale, the use of materials, and physical composition to assure visual compatibility, consistency, and integration with the overall character of the battlefield landscape. The following recommendations apply:

- Assemble a design team, including a landscape architect, architect, and park maintenance staff to develop park-wide design guidelines.
- Consider carefully the character and identity that is appropriate for necessary non-historic features associated with Wilson's Creek NB.
- Review existing conditions documentation photographs for current examples of site furnishings, fencing, road edging materials, circulation surfacing, signage, and visitor use and interpretation features. Consider the viability of existing features to serve as a park-wide standard.
- Review product catalogues for images of appropriate features.
- Review as a group the individual proposed elements for inclusion within the design guidelines.
- Develop details, installation procedures, and other supporting information for each standard feature.
- Consider the palette in its totality to ensure the individual elements are cohesive and work well together before making final selections.

16. Establish a comprehensive landscape stewardship and monitoring program

Introduction

Restoration and stewardship of the natural systems and native landscapes at Wilson's Creek NB are critical to the preservation of the site's cultural and natural resources. They are also integral components of a comprehensive prevention and control program for invasive species. Restoration projects need to be based on both general principles and site-specific considerations and analyses. Natural resource managers need to stay current with the latest land management techniques and research to provide them with information for the development of a wide range of environmentally sound management strategies and monitoring tools. Regular and systematic monitoring of native landscape restorations is a key factor to determining the progress or success of restoration projects.

Training of facility management staff in the restoration and stewardship of native landscapes is essential. Native landscape stewardship practices differ from standard landscape maintenance practices because of the focus on perpetuating sustainable natural systems rather than manicured landscapes. Through training programs and with the assistance of natural resource managers specializing in native landscape restoration, the park can develop specialized maintenance specifications for the stewardship and monitoring of the native landscapes across the park.

Considerations

Because landscapes change seasonally, specifications for ongoing maintenance and management should be organized in a calendar format. During each season or month, the calendar can be referenced to determine when, where, and what type of stewardship is needed. For example, control of invasive species such as cool season grasses is best done in the early spring before the native warm season grass species have had a chance to germinate. A stewardship calendar can identify times of the year when activities such as weed control (e.g. herbicide application and mowing), seed installation, and vegetation monitoring are scheduled to occur. In turn, resource managers can identify staff needs and determine work priorities.

Depending on the level of sophistication desired, one approach to documenting maintenance data and recording change over time is to use a computerized geographical or visual information system. Such a system could include plans, maps, and photographs of the site's landscape features.

If this data is not available, a manual or notebook can be developed to organize and store important information. This approach allows managers to start at any level of detail and to begin to collect and organize information about specific landscape features. The value of these maintenance records cannot be overstated. These records will be used in the future by historians and land managers to understand how the landscape has evolved with and responded to the ongoing care of the maintenance staff.

The planning, treatment, and stewardship of cultural landscapes requires an adaptive management approach to assist land managers in making educated treatment, management, and maintenance decisions. Proper and timely stewardship will protect the character of Wilson's Creek NB by recognizing that native landscape management needs and restoration approaches may change over time.

Recommendations

- Use the stewardship and monitoring program to educate the general public about the benefits of native landscapes and the techniques and approaches that are used to sustain them.

- Develop the following key elements to ensure establishment of a successful program:

  — access to current, reliable scientific and management information

  — rapid and accurate species identification

  — standard procedures for risk assessment

  — an adaptive management approach to account for changing native landscapes and the approaches used to manage them

  — adequate technical assistance (e.g. monitoring, information sharing, research and development, and technology transfer)

  — an annual budget that includes funding for stewardship and monitoring activities in perpetuity

- Develop a prescribed burn plan that maximizes the size of burn units and attempts to burn annually or as frequently as fuel loads and/or park resources permit.

- Consider the fire history information available to park personnel at the time of development of this CLR in developing a prescribed fire plan:

  Fire History[8]

  Fire in the Ozarks is "as essential an ecological process as rainfall." Regular ground fires are the predominant ecological process that created and maintained the open woodland and savanna structure (Simon 2002). Historically humans used fire to improve travel, for hunting wild game, to promote nut and berry production, to prepare sites for agriculture, and to improve browsing and grazing conditions (Guyette 2004).

  Traditionally fire histories are based on 1) qualitative information such as explorer notes, land survey notes, early settler diaries, and historic maps. Bearss (1978) and Gremaud (1986) used these resources to compile their studies; 2) some sort of quantitative data that documents the fire history. This information is usually gathered from fire scars, pollen cores, or rodent middens. The Karst geology of the Ozarks usually rules out pollen cores, and rodent middens are limited to the Southwestern United States. Fire histories in the Ozarks are typically based on fire scar data.

[8] Information provided by Gary Sullivan, Chief, Resources Management, Wilson's Creek National Battlefield, June 2004.

Based on fire scar data Guyette (1982) predicted a fire frequency of 3.2 years (1730 to 1870) on an Ozark glade in southwestern Missouri (near Ava, MO); after 1870 it dropped to 22 years. Fire frequency has been positively correlated with human population densities (Guyette 2004), but after 1830 the Osage Tribe was displaced and the migrations of the Shawnee, Delaware, and Cherokee Tribes through the Ozarks were complete fire frequency declined dramatically (Dey 2004). Guyette (1991) also predicted a fire frequency of 4.3 years (1710 to 1810) on a post oak savanna near the research site near Ava. After 1810 the fire free interval climbed to 6.4 years. Guyette states that "An increase in oak stems of sapling size may have resulted from the low fire frequency between 1810 and 1850." If a similar drop in fire frequency was followed by an increase in oak saplings at Wilson's Creek this research would help corroborate eye witness accounts of the battle and a sketch of "Bloody Hill" that documents an abundance of oak saplings up to 20-25 feet tall with some larger savanna trees present. In the Ozarks topographic roughness is positively correlated with the length of mean fire intervals (Guyette, 2004). Wilson's Creek is less steep and further west than the two sites near Ava, therefore, the frequency was likely shorter. Dey (2004) compared the mean fire return intervals for four sites in the Missouri Ozarks. Before 1830 the fire frequency is positively related to human population density, after 1830 population density is inversely correlated with fire frequency due to cultural changes land use effects (i.e. cultivation and grazing) that reduce the frequency and severity of fires. All four of these sites are 25 miles or more east of Wilson's Creek NB, therefore, the mean frequency may have been lower at Wilson's Creek.

Table 2—A comparison of mean fire return intervals at White Ranch State Forest, Caney Mountain Wildlife Refuge, Laclede County, and Cedar Glades

Period	WRSF	CMWR	LACCO	CEDAR
	- - - - - - - - - - - - *years* - - - - - - - - - - - -			
1710–1830	3.7	4.8	3.0	3.3
1831–1980	7.6	6.9	12.5	9.4

WRSF = White Ranch State Forest; CMWR = Caney Mountain Wildlife Refuge; LACCO = Laclede County; CEDAR = Cedar Glades.
All sites are more than 50 km from the White Ranch State Forest.

January 6, 2004, Rich Guyette was consulted by Chief of Resources Management, Gary Sullivan, during a Fire Management Workshop. Based on his experience and extensive dendrochronology database he felt that the mean fire interval for Wilson's Creek between 1700 and 1800 was 3-5 years. However, information based on fire scar data from oaks should be used with caution. Dey (2004) points out that post oaks are very resistant to fire scarring by low intensity fires. This may result in an under estimate of the number of fires in post oaks growing under low intensity surface fire regimes. In short, mean fire intervals determined from fire scars on oak trees should be viewed as minimum fire return intervals. The mean fire interval that created and maintained the savanna landscape at Wilson's Creek NB was likely somewhere between 1 and 3 years.

- Consider the use of a floristic quality assessment methodology to monitor the native landscape restorations and to help guide the stewardship process.

Implementation

- Keep current records of treatment work including methods and techniques used as well as their success or failure. This may include supporting photographic materials (e.g. photo stations in restoration areas to monitor changes over time), specifications followed, and a summary assessment. New technologies that have been successfully used should be highlighted. Ideally, this information should be shared with interested land managers, biologists, natural resource managers, and site stewards for further dissemination, evaluation, and feedback.

- Document the need for further research, equipment, or maintenance needs. This may include site-specific or contextual historical research, surveys for rare plant species, or materials for testing future stewardship applications such as new herbicides or biological controls for invasive species management.

- Consult with a biologist or natural resource manager to maximize the benefit of project work and to minimize the potential for data loss—all primary documents should be organized and preserved as archival materials. This may include field notes, maps, drawings, photographs, plant specimens, and other relevant information.

- Conduct regular and systematic monitoring of native landscape restorations to determine the progress or success of restoration projects and any necessary maintenance or remediation.

Measures to Evaluate Success of Restoration Measures

Floristic Quality Assessment Methodology

Although there are many ways to monitor native landscape restorations and measure their performance, this approach emphasizes vegetation development and floristic quality assessment (FQA) methods. In summary, vegetation is sampled along transect lines established within representative portions of the restoration units. A qualitative inventory of the vegetation across the entire landscape unit is also recorded. These vegetation sampling protocols are repeated every year so that trends in floristic development can be monitored over time.

A critical component in the evaluation of a restoration project is the determination of the extent of native species recruitment and establishment across the landscape. A useful method is analysis of the conservatism and diversity of species that are recorded during monitoring. Conservatism represents the degree to which an experienced field botanist has confidence that a given species is representative of a high-quality, remnant habitat (i.e. those natural areas with intact presettlement structure, composition, and processes). Native plant species display varying degrees of tolerance to disturbance, as well as varying degrees of fidelity to specific habitat integrity. Native plants of a given region exhibit an observable range of conservatism, and each native species can be assigned a *coefficient of conservatism* (C value) ranging from 0 to 10, "weedy to conservative," that reflects its disposition.

The Mean C is the average coefficient of conservatism for a site. The Floristic Quality Index (FQI) is a statistic derived by multiplying Mean C by the square root of the number of species

inventoried; thus, the FQI is a function of conservatism and diversity. In general, site inventories with FQI values less than 20 are degraded or derelict plant communities, or are very small habitat remnants. Site inventories with FQI values in the twenties through low thirties suffer from various kinds of disturbance, but generally have potential for habitat restoration and recovery. When site inventories have FQI values in the middle thirties or higher, and/or have Mean C values of 3.4 or higher, there is sufficient native character present for the area to be at least regionally noteworthy. Site inventories with indices in the middle forties and higher are significant natural area remnants of statewide importance.

As change occurs over time due to management, Mean C and FQI values will reflect the extent to which conservative species are being recruited and the floristic quality is improving. If an inventoried site has a large proportion of conservative plants, the Mean C is higher; in a degraded site, the Mean C is lower. The presence of a large proportion of adventive species and non-conservative native species suggest that an area is degraded. The Mean C and FQI values for a sampling transect are calculated for the transect as a whole and for the average quadrat; a comparison of floristic values between the transect and quadrat level is useful to understand the uniformity of native species establishment.

Another useful measurement that is important in the evaluation of native landscape restorations is that of the wetness value (W). Each plant species has been assigned a wetness category that indicates its probability of occurrence in a wetland. Plants are designated as Obligate Wetland (OBL=-5), Facultative Wetland (FACW=-3), Facultative (FAC=0), Facultative Upland (FACU=3), and Obligate Upland (UPL=5). For about 20 percent of our flora, a "+" or "-" sign has been attached to the three *Facultative* categories to express the exaggerated tendencies of those species. The "+" sign denotes that the species generally has a greater estimated probability of occurrence in wetlands; the "-" sign denotes that it generally has a lesser estimated probability of occurrence in wetlands. Mean wetness values can be compared annually to gain an understanding of what type of plant species have become established across the restoration site.

Methods for Sampling Vegetation

Recommended methods should follow ongoing monitoring efforts, or at a minimum be comparable. The vegetation monitoring protocol used at Wilson's Creek NB is being revised, a draft should be available by November 15, 2004.

The following protocol for monitoring has been abstracted from Masters (1997), with the author's permission.[9]

> For an overall picture of a particular plant community, begin with a complete inventory. Plants should be recorded at least twice during the growing season, once early enough for the spring flora and a second time late enough for the fall flora. Record as many species as possible over the entire site to capture the full floristic variety.
>
> Inventories are useful, however, they do not show which species are increasing and decreasing, or which are common and which are rare. Measuring such floristic changes over time can best be achieved through quantitative sampling repeated at various intervals. Sampling is done when the population or area of interest is too

[9] Linda A. Masters, "Monitoring Vegetation" In *The Tallgrass Restoration Handbook for Prairies, Savannas, and Woodlands*. Stephen Packard and Cornelia Mutel, eds. (Washington: Island Press, 1997).

large to census in its entirety. When done efficiently, sampling provides a picture of the entire population or area with a minimum of time and effort. However, when done poorly, sampling can lead to inaccurate conclusions. There are two types of errors that can occur with monitoring, "sampling errors" and "nonsampling errors." Nonsampling errors are the result of human activity, such as flawed transcription and recording of data, or incorrect and inconsistent plant identification. Therefore, it is very important that the sampling methods be clearly defined so that they can be repeated not only by yourself but also by others. Defining the methods clearly will help reduce nonsampling error and problems due to changes in monitoring personnel.

When to sample depends largely on the questions being asked. If you are interested in monitoring the recovery of the fall flora in a degraded savanna, sample in the fall. If you are interested in the recovery of a sedge meadow, sample in late spring or early summer when the sedges are easily identifiable. How often to sample also depends on the questions being asked. A plant community that changes slowly does not need to be sampled as often as one that changes more quickly. For example, you may want to sample the groundcover in a savanna every year or two, but sampling the trees needs to be done no more often than once every five to ten years. It will also be valuable to conduct baseline (prerestoration) sampling to document the condition of the site before restoration begins.

Three types of samples are commonly used to monitor the composition of the vegetation and its changes with restoration: plots, quadrats, and transects. Plots are usually large sampling areas (e.g., one hectare, one-quarter acre, or 100 feet by 100 feet) that are often permanently marked. They can be placed randomly but are often purposely placed in an area judged to be representative of the site monitored. They are frequently used in woodlands to sample trees.

Quadrats are typically much smaller than plots. They can range in size from $1.16m^2$ to $1m^2$; the recommended size is $1/4\ m^2$. They can be arranged regularly in transects or scattered randomly over an entire site. Transects are usually lines of quadrats, which may or may not be randomly placed. One simple form of sampling is to select arbitrarily one or more lines that pass through all of the important vegetative features of the site. In order to resample the same transect later to detect changes through time, permanently mark the transect.

Samples should be sufficiently numerous so as to achieve a representative amount of plant frequency and coverage data. If you want to detect changes in the extent of a community or encroachment, place quadrats from one area into another. Spacing and number of quadrats is especially important in this instance because too few quadrats widely spaced may fail to detect any change in the community soon enough. To incorporate randomness into a method using regular spacing, place the first quadrat randomly, one to ten paces, along the transect; then proceed using fixed spacing, such as five pace intervals.

Plot and quadrat shapes are usually round or quadrangular. Plots commonly range from 0.1ha to 1ha. Sizes of quadrat frames typically range from $0.1m^2$ to $1m^2$. For prairie systems, the most efficient quadrat is a square, 0.5m on a side ($0.25m^2$). This size is small enough that all the plants in the quadrat can be seen in one field of vision and more samples can be established per unit time. The larger the quadrat

frame, the more difficult it becomes to see all the plants at once, the harder it is to determine an accurate cover value, and the more time it takes. Quadrats that are too small will require an excessive number of samples to describe the variability present in most grassland systems. A 1/4 m^2 square quadrat frame can be constructed from wood or PVC pipe, 1/2 m on a side. One side of the quadrat can be left off so that it will fit easily around bulky plants; and if the joints are hinged, the quadrat can be folded for easy carrying. The choice of plot and quadrat size and shape is up to you, but it is important to stay with whatever method you begin with if you want to make meaningful comparisons.

When monitoring a natural community, record a complete list of all species present in each quadrat and, if desired, their estimated cover. "Cover" is defined as the ground area covered by the vertical projection of the above-ground plant parts. It is important to consider what is included in the cover estimate. For example, will you include plants not rooted in the quadrat, but which arch over it, such as vines? Record in your methods what is to be included as part of the cover estimate so it can be estimated consistently with repeated sampling.

Percent cover is the estimated percent of cover for each species in the quadrat, while cover classes lump percent cover estimates into broader measures such as: 1 = 1-10 percent, 2 = 11-30 percent, 3 = 31-50 percent, and 4 = 51-100 percent. If the abundance of the species is to be integrated, a cover/abundance coefficient can be assigned that combines an estimated cover with an estimated distribution and abundance within the quadrat. For example, give each species in a quadrat a cover abundance coefficient from 1 to 5 as follows:

1 = species consisting of one to few stems in only one quarter of the quadrat.

2 = species occupying 1 to 2 quarters and numbering several stems.

3 = species occupying 2 to 3 quarters with cover and density notable in each.

4 = species occupying 3 to 4 quarters with a regular density throughout.

5 = restricted to species that dominate the entire quadrat.

Do not get bogged down trying to be extremely precise with the cover values. As long as the values are applied consistently, the results will be useful and generally repeatable.

Cover estimate is one measure used to determine a species' importance relative to all other species in the sample area. Another measure of importance is derived from a species' frequency, which is the number of quadrats in which a particular species occurred. Using the Floristic Quality Assessment methodology described above, relative frequency is calculated by dividing the frequency of one species by the total frequency of all species. Relative cover is calculated by dividing the total cover of one species by the total cover of all the species. The relative importance value (RIV) of a species is figured by adding the relative frequency (RFRQ) and relative cover (RCOV) together (RIV 200). Some people find it clearer to divide this number by two (RIV 100).

An important thing to remember about a table of relative importance values is that the rank of a species will not remain the same throughout the growing season or from year to year. Rank is, in part, a factor of the plant's structure and is influenced by the year's weather, herbivory, mortality, reproduction, etc. The relative importance of a certain plant species may drop when more species are added, or rise if species drop out, even though the plant's absolute cover and frequency remain the same. If vegetation is to be evaluated based on changes in the cover of certain species, it is important to sample the plots or transects at the same time of the year, using the same cover value guidelines. Remember, the RIV rankings are like a "snapshot" of the restoration at the time of sampling. It is difficult to categorize changes in cover, frequency, or importance values as positive or negative unless you have a hypothesis about what these changes could or should be at a particular site.

As discussed earlier, native landscape stewards must make value-based decisions concerning the management and floristic direction of their work. It is not sufficient to know if the numbers of certain plants are increasing or decreasing; you must also be able to evaluate whether those changes are positive or negative. Nor is it sufficient merely to distinguish between native and exotic species. It is crucial to know whether these are the native species that can coalesce into functioning communities that will form a part of a sustainable ecosystem. If certain native plant species can be correlated with ecological integrity, then their presence would be an indicator of system health or quality.

The Floristic Quality Assessment (FQA) method can be used to analyze both site inventory lists and samples. It allows anyone with the requisite botanical experience to obtain similar results. Essentially, FQA allows the ecologist to reduce a complex pattern of change to a few "key statistics" that are sensitive enough to codify responses indicative of the plant community or ecosystem as a whole.

Wilson's Creek
National Battlefield

Republic, Missouri

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Cultural Landscape Report
Volume 1

Prepared for

National Park Service
Midwest Regional Office
Omaha, Nebraska

Prepared by

John Milner Associates, Inc.
Charlottesville, Virginia

with

Rivanna Archaeological Consulting
Charlottesville, Virginia

Conservation Design Forum
Elmhurst, Illinois

and

Bahr Vermeer & Haecker, Architects
Lincoln, Nebraska

• • • • • • •

September 2004

Credits

National Park Service

Midwest Regional Office

Sherda Williams, Historical Landscape Architect, Project COTR, Part 1
Marla McEnaney, Historical Landscape Architect, Project COTR, Part 2

Wilson's Creek National Battlefield

Ted Hillmer, Superintendent, Wilson's Creek
Richard Lusardi, Superintendent, Lincoln Home
Gary Sullivan, Chief of Resources and Facility Management
Mike DeBacker, Prairie Cluster and Heartland I&M Network Coordinator
Ron Miller, former Chief of Maintenance
Jeffrey Patrick, Librarian
Connie Langum, Historian
John Sutton, Chief of Interpretation and Visitor Services
Lisa Thomas, former Prairie Cluster I&M Coordinator

John Milner Associates, Inc.

Rob McGinnis, Principal-in-Charge
Liz Sargent, Historical Landscape Architect and Project Manager
Rachel Evans Lloyd, Project Landscape Architect
Julie Basic, Project Designer
Adriane Fowler, Project Designer
Krista Schneider, Project Designer
Matt Whitaker, Project Designer
Pam Liu, Intern Landscape Architect

Bahr Vermeer & Haecker, Architects

Dan Worth, Principal-in-Charge
Lori Unick, Project Architect

Conservation Design Forum

Gerould Wilhelm, Botanist/Ecologist
Sarah Utter, Restoration Ecologist
Douglas Ladd, Consulting Botanist/Ecologist

Rivanna Archaeological Consulting

Benjamin Ford, Project Historian and Archeologist

Wilson's Creek
National Battlefield

Republic, Missouri

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Cultural Landscape Report
Volume 2

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Omaha, Nebraska

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Charlottesville, Virginia

with

Rivanna Archaeological Consulting
Charlottesville, Virginia

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• • • • • • •

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National Park Service

Midwest Regional Office

Sherda Williams, Historical Landscape Architect, Project COTR, Part I
Marla McEnaney, Historical Landscape Architect, Project COTR, Part II

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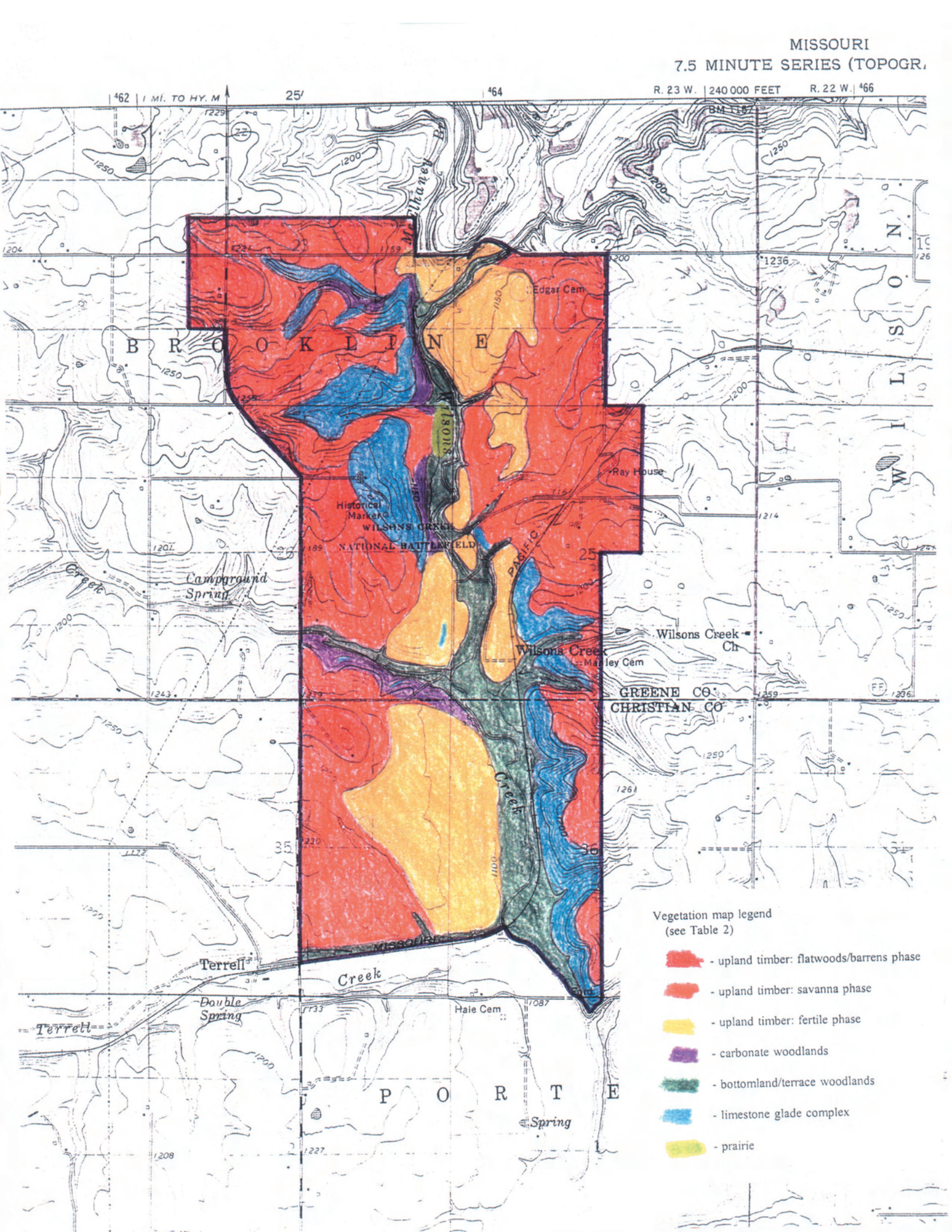
Appendices

APPENDIX A

Pre-settlement Vegetation

Prepared by Conservation Design Forum during spring 2000 based on research and field investigations.


MISSOURI
7.5 MINUTE SERIES (TOPOGR.
R. 23 W.
240 000 FEET
R. 22 W.
1 MI. TO HY. M
BROKLINE
Edgar Cem
Ray House
Historical Marker
WILSONS CREEK
NATIONAL BATTLEFIELD
Campground Spring
Wilsons Creek
Wilsons Creek Ch
Manley Cem
GREENE CO.
CHRISTIAN CO
Terrell
Creek
Double Spring
Terrell
Hale Cem
PORTE
Spring
Vegetation map legend
(see Table 2)
- upland timber: flatwoods/barrens phase
- upland timber: savanna phase
- upland timber: fertile phase
- carbonate woodlands
- bottomland/terrace woodlands
- limestone glade complex
- prairie

APPENDIX B

Witness Tree Data

APPENDIX C

Annotated Flora of Wilson's Creek National Battlefield

Prepared by Conservation Design Forum during fall 1999 and spring 2000 based on research and field investigations.

APPENDIX D

Floristic Quality Data

Floristic Quality Data for the Vegetative Communities Identified During Field Investigations in Support of Existing Conditions Documentation, fall 1999 and spring 2000, and revised spring 2002, follows.

APPENDIX E

Site Weed Management Plan Template

This template developed by The Nature Conservancy is a good model for Wilson's Creek National Battlefield to consider in developing its own similar program.

Site Weed Management Plan Template
TNC's Wildland Invasive Species Program
Revised: Mandy Tu & Barry Meyers-Rice/WISP

SITE WEED MANAGEMENT PLAN

FOR

(***NAME of PRESERVE or CONSERVATION AREA)***
(***TOWN, STATE***)

(PERIOD; e.g. 2001-2005)

PREPARED BY (*Authors, Contributors*)(*Program*)
THE NATURE CONSERVANCY

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1. INTRODUCTION

A. Description and purpose of the site (preserve or managed area)

*Briefly describe distinctive biological communities, habitat types, land-use histories, valued species, conservation targets and goals, and any major threats to achieving those targets and goals. Describe special features of any management sub-units on the site. When describing the management goals, focus on what you are managing **for**; clearly state what you **want** on the site. For example, you may be managing for the following:*

1. *a biological community and the processes (e.g., fire, flooding) that maintain it;*
2. *a species or suite of species that are rare or otherwise valued;*
3. *a corridor or a migratory stopover.*

B. Description of how certain plant species ("weeds") interfere with management goals

Use this section to justify the use of labor and resources to eliminate or control certain plant species in terms of your conservation targets and goals. Briefly describe how these species degrade the site, or could do so if allowed to proliferate. See Section 2.B.II. for a list of impacts weeds can have on natural areas. Revisit this section and, if necessary, revise it after completing Section 3 (Specific Control Plans for High Priority Species).

If you determine the impacts of certain species are not as damaging as had been thought and need not be controlled, you can use this section to explain that too.

Most species considered "weeds" in natural areas are invasive, i.e. able to move into and dominate or disrupt natural communities or restoration projects. Both non-native and native species may be "weeds". We define "non-native species" as those species that arrived in and colonized an area only with direct or indirect human assistance, even if they are native elsewhere on the continent or in the state. They may also be called "non-indigenous", "alien", "exotic", "adventive" or "naturalized" species. Situations where "native" species may be regarded as "weeds" include: a) when Phragmites *has invaded a site that previously provided important open-water habitat for waterfowl; and b) when native woody species have invaded a prairie site.*

C. Inventory of plant species that interfere with management goals

Inventory populations of weeds located on and near the site. Map these populations, estimate the area(s) they cover, and note whether they are increasing, stable or decreasing. If possible, make one map with locations of all weed species populations shown and separate overlay maps for each weed species. You can use these maps as you develop specific control strategies for high-priority species (Section 3). This information should be updated annually.

2. OVERVIEW OF WEED MANAGEMENT PLAN

A. General Management Philosophy

Weed control is part of the overall site management and restoration program. We focus on the species and communities we want in place of the weed species, rather than on simply eliminating weeds. We will implement preventative programs to keep the site free of species that are not yet established there but which are known to be pests elsewhere in the region. We will set priorities for the control or elimination of weeds that have already established on the site, according to their actual and potential impacts on native species and communities, particularly on our conservation targets. We will take action only when careful consideration indicates leaving the weed unchecked will result in more damage than controlling it with available methods.

We use an adaptive management strategy. First, we establish and record the goals for the site. Second, we identify species that block us from reaching these goals and assign them priorities based on the severity of their impacts. Third, we consider methods for controlling them or otherwise diminishing their impacts and, if necessary, re-order priorities based on likely impacts on target and non-target species. Fourth, we develop weed control plans based on this information. Fifth, the plan is implemented, and results of our management actions monitored. Sixth, we evaluate the effectiveness of our methods in light of the site goals, and use this information to modify and improve control priorities, methods and plans. Finally, start the cycle again by establishing new/modified goals.

We set priorities in the hope of minimizing the total, long-term workload. Therefore, we act to prevent new infestations and assign highest priority to existing infestations that are the fastest growing, most disruptive, and affect the most highly valued area(s) of the site. We also consider the difficulty of control, giving higher priority to infestations we think we are most likely to control with available technology and resources.

Add more detailed information on how you set priorities. Use Table 1 in the weed template excel worksheet to list your priorities. What follows is a stepwise approach for prioritizing species and specific infestations for control. Another, more detailed, priority-setting system is presented in the Handbook for Ranking Exotic Plants for Management and Control (Hiebert and Stubbendieck 1993). This handbook is available on the web at (http://www.aqd.nps.gov/pubs/ranking/).

Setting Priorities

The priority-setting process can be difficult, partly because you need to consider so many factors. We find that it helps to group these factors into four categories that you can think of as filters designed to screen out the worst weeds:

I. current extent of the species on or near the site;
II. current and potential impacts of the species;
III. value of the habitats/areas that the species infests or may infest; and
IV. difficulty of control.

*The categories can be used in any order, however, we emphasize the importance of the **current extent of the species** category, and suggest it be used first. In the long run, it is usually most efficient to devote resources to preventing new problems and immediately addressing incipient infestations. Ignore categories that are unimportant on your site.*

Below we suggest how species should be ranked within the four categories. If a species is described by more than one of the criteria in a given category, assign it the highest priority it qualifies for. You may assign priority in a ranking system (1, 2, 3..., n) or by class (e.g., A = worst weeds, B = bad weeds, C = minor pests).

I. Current extent of the species: *Under this category, priorities are assigned to species in order to first, prevent the establishment of new weed species, second, eliminate small, rapidly-growing infestations, third, prevent large infestations from expanding, and fourth, reduce or eliminate large infestations. To do this, assign priorities in the following sequence:*

1. *Species not yet on the site but which are present nearby. Pay special attention to species known to be pests elsewhere in the region.*
2. *Species present as new populations or outliers of larger infestations, especially if they are expanding rapidly.*
3. *Species present in large infestations that continue to expand.*
4. *Species present in large infestations that are not expanding.*

You may have to "live with" weeds/infestations you cannot control with available technology and resources. However, keep looking for innovations that might allow you to control them in the future.

II. Current and potential impacts of the species: *Order priorities under this category based on the management goals for your site. We suggest the following sequence:*

1. *Species that alter ecosystem processes such as fire frequency, sedimentation, nutrient cycling, or other ecosystem processes. These are species that "change the rules of the game", often altering conditions so radically that few native plants and animals can persist.*
2. *Species that outcompete natives and dominate otherwise undisturbed native communities.*
3. *Species that do not outcompete dominant natives but:*
   a. *prevent or depress recruitment or regeneration of native species (for example, the forest understory weed garlic mustard may depress recruitment by canopy dominants); OR*
   b. *reduce or eliminate resources (e.g., food, cover, nesting sites) used by native animals; OR*
   c. *promote populations of invasive non-native animals by providing them with resources otherwise unavailable in the area.*
4. *Species that overtake and exclude natives following natural disturbances such as fires, floods, or hurricanes, thereby altering succession, or that hinder restoration of natural communities. Note that species of this type should be assigned higher priority in areas subject to repeated disturbances.*

III. Value of the habitats/areas the species infests or could infest: *Assign priorities in the following order:*

1. *Infestations that occur in the most highly valued habitats or areas of the site - especially areas that contain rare or highly valued species or communities and areas that provide vital resources.*
2. *Infestations that occur in less highly valued portions of the site. Areas already badly infested with other weeds may be given low priority unless the species in question will make the situation significantly worse.*

IV. Difficulty of control and establishing replacement species: *Assign priorities in the following order:*

1. *Species likely to be controlled or eliminated with available technology and resources and which desirable native species will replace with little further input.*
2. *Species likely be controlled but will not be replaced by desirable natives without an active restoration program requiring substantial resources.*
3. *Species difficult to control with available technology and resources and/or whose control will likely result in substantial damage to other, desirable species.*
4. *Species unlikely to be controlled with available technology and resources.*

Finally, weed species whose populations are decreasing and/or those that colonize only disturbed areas and don't move into undisturbed habitats nor impact recovery from the disturbance can be assigned the lowest priorities.

B. Summary of Specific Actions Planned

Briefly (1-3 paragraphs) describe or outline your weed control plan. Note which species you plan to control, where and over what period you plan to do so, the methods you plan to use, which species you plan to monitor and, how you plan to do so. You may also briefly explain why you do not plan to control certain species.

C. Tables

Open the Excel spreadsheet "WeedTabl.xls" and enter data into its tables. You may make hard copies of the tables, but you will not benefit from the automatic calculations in the computer version.

Table 1. Prioritized List of Weed Species
Set ranks or categories using Section 2B for guidelines.

Table 2. Weed Management Plan Implementation Schedule
Schedule the planning, surveying, and treatment for each target weed for at least the next year.

Table 3. Projected Resource Costs to Implement Weed Management Plan
Revise this table annually after comparing estimated to actual costs (obtained from Table 5).

Table 4. Itemized Actual Annual Cost and Labor Worksheet(s) for Each Target Weed
Enter data for each project or target weed to account for yearly costs and labor.

Table 5. Projected and Actual Resource Uses
After each year, examine the difference between actual and estimated resource costs. Use these results to estimate new resource costs for the upcoming year(s).

(copy this and next page for additional species)

3. SPECIFIC CONTROL PLANS FOR HIGH PRIORITY WEED SPECIES

***Scientific name:*_____ *Common name*:_____**

Updated _____

A. PRIORITY _____

B. DESCRIPTION

(In 2-3 lines list habit, life history, native range, and other outstanding characteristics)

C. CURRENT DISTRIBUTION ON THE SITE

(Refer to maps, Section 1C)

D. DAMAGE & THREATS

(Outline damage caused and threats posed by the species. Refer to Section 1B)

E. GOALS

(Outline long-term goals for this species. For example, you may want to reduce numbers of this species so that it no longer threatens populations of a rare species or so that it does not affect fire frequencies on the site).

F. OBJECTIVES (Measurable)

*(Establish **measurable** objectives for the planned control activities. Include:*

***1**. the **impact** on numbers, density, cover, etc. that you want to achieve;*

***2.** the **size** of the area in which you hope to achieve this;*

***3**. the **period** in which you hope to achieve it.*

For example you may state your objectives in terms of reducing percent cover of the species by 50% over an area of 5 acres within 3 years. Another possible objective would be eliminating the species from the site within 2 years.)

G. MANAGEMENT OPTIONS

Viable control options are:

(1) *No treatment;*

(2) *(Treatment alternative 1);*

(3) *(Treatment alternative n); etc.*

(Briefly discuss the alternatives, indicate which are preferred and the conditions (size of area treated, location, phenology, total anticipated cost, etc.) under which they may be used. Build in restricted flexibility to allow those carrying out the plan options; conditions in the field may differ from those you anticipated. State who the field-staff should contact when none of the listed alternatives can be carried out.)

H. ACTIONS PLANNED (Treatments and monitoring)

(Briefly describe the locations to be treated, materials and methods to be used, and an approximate schedule for control and monitoring activities. If several methods are to be tested, outline the design of the planned experiment or demonstration.)

***Scientific name:*_____ *Common name:*_____**

Updated _____

I. HOW ACTIONS WILL BE EVALUATED (Criteria for success)
(Outline the methods that will be used to monitor control activities and the criteria that will be used to evaluate success or failure of the program. The criteria for success should be based on the program's objectives and goals. If you develop forms to be used when collecting monitoring data, include copies as Appendix 6)

J. RESOURCE NEEDS
(Estimate the amount of time [for staff, interns and volunteers] and money that will be required to carry out the planned control, monitoring and evaluation for this species.)

K. RESULTS OF EVALUATION
(This section is to be filled in later, preferably within 1 year, when monitoring data has been taken and evaluated, at least preliminarily. The evaluation should be used to determine whether any of the sections B-K above should be modified.)

4. REFERENCES

List references cited or used.

5. APPENDICES

Appendix 1. EMERGENCY INFORMATION: DIRECTIONS AND MAP TO NEARBY HOSPITALS OR CLINICS

Be sure that phone numbers and directions are current.

Appendix 2. BLANK MAPS/SAMPLE MAPS

Attach copies of the blank map(s) of the preserve/site, and of (overlaid) maps depicting the extent of the target weed(s) on the site here.

Appendix 3. FORMS USED IN COLLECTING MONITORING DATA

Attach copies of data collection sheets here.

Use the following 3 appendices if herbicides are to be used.

Appendix 4. HERBICIDE USE PROTOCOLS

After noting which herbicide(s) will be used and roughly how much will be used, outline any state and local requirements for applicator licensing and/or posting of treated areas. Then, BRIEFLY describe how the herbicide(s) will be stored, mixed and transported. Describe how excess herbicide and any equipment or clothing that has become contaminated will be disposed of. Describe emergency first aid procedures and plans for responding to spills or contamination. List who may apply the herbicide(s), and what protective gear will be available for them.

You may use the "Policy, Procedures and Guidelines for Use of Herbicides on Land Managed by The Nature Conservancy" to complete this appendix. Copies are available from TNC's Weed Management & Research Program.

Appendix 5. HERBICIDE USE RECORD FORMS

When using herbicides it is critical (and, in many cases, required by law) to keep detailed records of all relevant information. Ideally, records would include data on the condition of the site prior to herbicide application, the type of species present, and percent cover of invasive and native species prior to application. This information will be valuable in evaluating the effectiveness of the herbicide. At the time of application, take detailed notes of the type and concentration of the herbicide, the amount, location, and method of application, weather conditions, and any other observations made during the course of application. This information is important in evaluating the project's success, improving methodology, and identifying mistakes. In addition, it documents the procedure for future site managers and biologists. As in Appendix 2, you may use "TNC's Policy, Procedures and Guidelines for Use of Herbicides…"

Appendix 6. HERBICIDE LABELS

Attach copies of the herbicide label(s) here.

APPENDIX F

Weed Management Plan Example

This example Weed Management Plan for the Cosumnes River Preserve, Galt, California, 2001-2005, should be considered as a model for a similar plan to be developed by Wilson's Creek National Battlefield.

Weed Management Plan

for

The Cosumnes River Preserve

Galt, California

2001 - 2005

Wildland Invasive Species Program
The Cosumnes River Preserve

The Nature Conservancy
Updated 9/2001 by Barry Meyers-Rice & Mandy Tu

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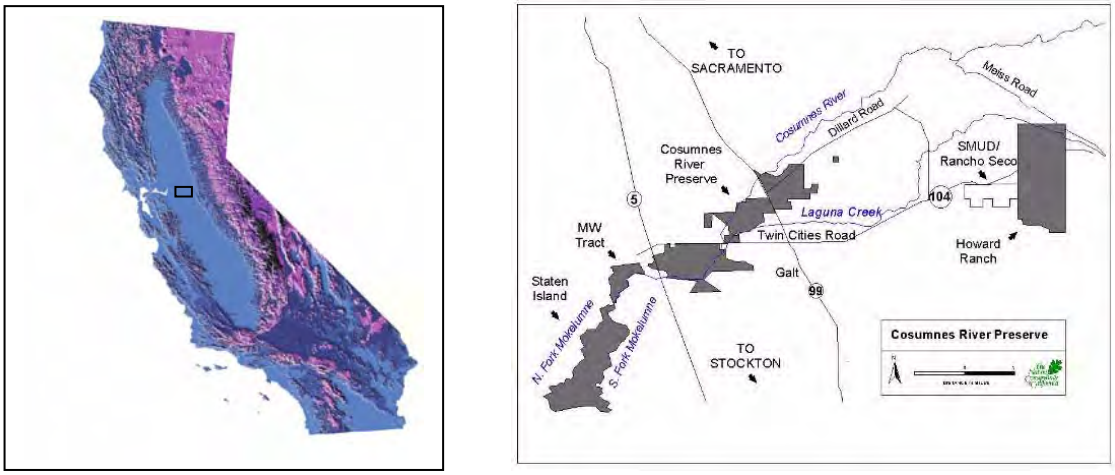
1. Introduction

A. Cosumnes River Preserve Description and Management Goals

The Cosumnes River is the only large waterway draining into California's Central Valley that is not dammed. Its watershed spans 3,276 km^2 (1,265 mi^2), and descends from an elevation of 2,316 m (7,600 ft) in the Sierra Nevada down to sea level. Restricted by only a small system of levees, the Cosumnes River floods seasonally. This flooding is essential for maintaining the riparian forests and freshwater marsh communities that have become degraded or completely lost elsewhere in California. These remaining natural communities lie along the Pacific Flyway and are important stopovers for many migratory birds, including greater and lesser sandhill cranes, tundra swans, northern pintails, and Canada geese.

The Cosumnes River Preserve was established in 1987 to protect valuable habitat in the lower reaches of the Cosumnes watershed. The preserve is part of the larger Cosumnes River project area that includes much of the watershed from the headwaters to the delta area. The long-term goal of the Project is to encompass a large and naturally functioning example of the Central Valley and foothill ecosystem with the full spectrum of the region's natural communities. It is located along the eastern edge of the Sacramento-San Joaquin Delta near the confluence of the Cosumnes and Mokelumne Rivers (Figures 1a & 1b), and the total area of protected land (owned by TNC and other partners) numbers approximately 16,000 ha (40,000 acres). Four natural communities occur on the preserve: seasonal and permanent wetlands, riparian communities, valley oak savannas, and grassland-vernal pool mosaics. Portions of the preserve remain in use as cropland and for grazing. Six partners own the land parcels that constitute the preserve: The Nature Conservancy, Ducks Unlimited, US Bureau of Land Management, California Department of Fish and Game, Sacramento County Department of Parks and Recreation, and California Wildlife Conservation Board.



Figures 1a & 1b: The Cosumnes River Preserve

This weed management plan has been written for the Cosumnes River Preserve 2001 boundaries that exist between I-5 and Highway 99, including the Castello and Valensin properties, but excluding Howard Ranch, Staten Island, and MW Tract (Figure 2). This part of the preserve has a major role in reaching two of the overall project's primary goals:

1. Preserving and restoring remnant Central Valley riparian forest communities and aquatic systems throughout the full length of the Cosumnes River, from the Sierran headwaters to the Central Valley floodplain. This includes: preserving the entire riparian community with a focus on plant species composition; creating riparian forest corridors by connecting existing patches of riparian forests; preserving and restoring natural river and tidal slough hydrology; and alleviating bank instability problems.

   Special attention is being given to enhancing populations of rare species which occur or occurred historically in this community, including Swainson's hawk, ferruginous hawk, yellow-billed cuckoo, willow flycatcher, bank swallow, yellow-breasted chat,

least Bell's vireo, giant garter snake (*Thamnophis gigas*), chinook salmon (*Onchorhynchus tshawytscha*), valley elderberry longhorn beetle (*Desmocerus californicus* ssp. *dimorphus*), and California hibiscus (*Hibiscus lasiocarpus*).

2. Preserving and restoring the permanent and seasonal wetlands (including vernal pools) that support resident and migratory waterfowl, fish, amphibians, and other invertebrates. The focus is on restoring the ability of the plant communities to provide food and shelter for these animals rather than on plant community composition. Special attention is being given to populations of greater and lesser sandhill cranes (*Grus canadensis*), northern pintail ducks (*Anas acuta*), and native fish (such as the Sacramento split-tail).

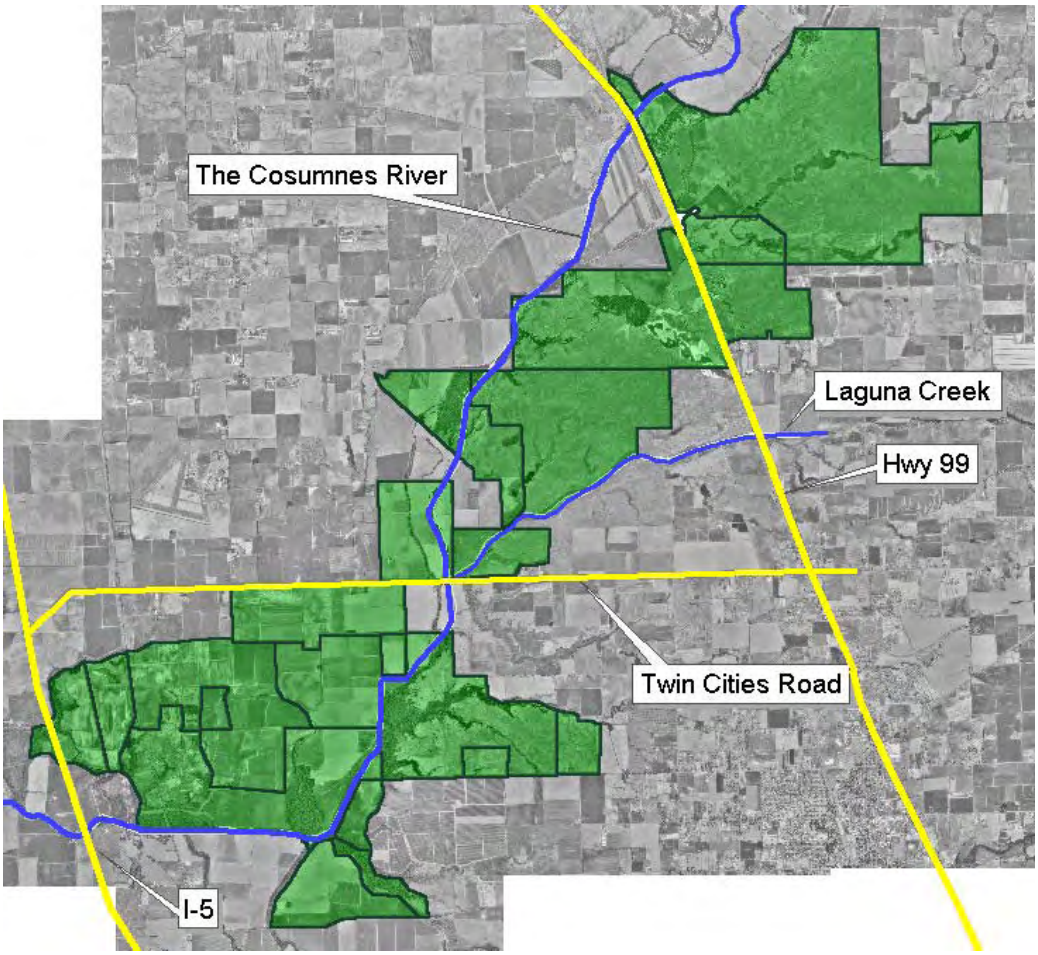


Figure 2: Cosumnes River Preserve

Three secondary management goals have been identified:

1. Conserving the preserve's grasslands and valley oak savannas while maintaining economically viable and ecologically compatible land uses. The focus is on maintaining waterfowl nesting habitat and quality rangeland and on preserving populations of valley oaks, native bunchgrasses and native forbs.
2. Helping develop compatible economic uses of land on portions of the preserve as a model for neighboring private lands. This includes encouraging agricultural techniques that reduce pesticide use and sediment runoff, and provide food and habitat for wildlife.
3. Serving as a public education resource and providing people opportunities to experience and further understand the region's diverse landscapes and biology. This is done by providing trails, a boardwalk, an interpretive center, tours and other activities.

B. How Weeds Interfere With Management Goals

The effects of the most troublesome weeds in the primary natural communities at the Cosumnes River Preserve are described below. Weed species found on roads and trails are also described. Sample weed survey maps are found in Appendix 2.

Riparian Forests

Riparian forest weeds include edible fig (*Ficus carica*), black locust (*Robinia pseudoacacia*), tree of heaven (*Ailanthus altissima*), Osage orange (*Maclura pomifera*), and honeylocust (*Gleditsia triacanthos*). These five tree species could alter community composition and structure if allowed to spread—in time they could dominate the canopy layer and even form monospecific stands as they have done or shown the potential to do in other Central Valley riparian forests. These changes would translate to a significant decrease in habitat quality. Populations of the fig, black locust, tree of heaven, and Osage orange are still on the preserve, and honeylocust, thus far, only occurs as small, isolated populations. Wych elm (*Ulmus glabra*) is another tree species that has been found only as small isolated individuals on the Preserve, has the potential to invade forested areas, and should be monitored for spread.

Woody species not yet on the preserve, yet found nearby, can pose new threats to the integrity of the forest community, and could decrease habitat quality for the conservation targets. Such weeds include Chinese tallow tree (*Sapium sebiferum*) and Chinese wisteria (*Sesbania punicea*).

The most important weeds that may modify both forested and non-forested riparian communities are Himalayan blackberries (*Rubus armeniacus*), perennial peppergrass (*Lepidium latifolium*), and fennel (*Foeniculum vulgare*). The effects of these species on riparian areas are not clear. The non-native Himalayan blackberry may outcompete and/or hybridize with the native California blackberry (*Rubus ursinus).* Meanwhile they might benefit some species of wildlife by providing additional food and shelter. (Together the blackberry species may reduce the recruitment of other riparian plants.) Perennial peppergrass infests and sometimes dominates former riparian forest sites, but it is uncertain whether it effects native tree recruitment. Fennel is common along roadsides on the preserve. While not a problem along the roadsides, it appears to prevent recruitment of valued plants when it grows in riparian communities. High profile infestations occur near the Visitor Center and on the Willow Slough Trail.

Arundo (*Arundo donax*) is not present on the preserve, but could spread from a nearby infestation on the Mokelumne River levee by the Franklin Boulevard bridge. Arundo is an aggressive invader that is a severe pest in other Californian riparian areas where it competes with native riparian species, promotes wildfire, and alters stream morphology and flow. Arundo does not provide food or nesting habitat for native animals.

Wetlands and Open Water

Water hyacinth (*Eichhornia crassipes*) and perennial peppergrass interfere with the primary management goals for wetland areas. Water hyacinth reduces sunlight and alters water chemistry, negatively affecting native aquatic plants and animals when it dominates tidal sloughs. The impacts of perennial peppergrass on wetland management goals are unclear. If it dominates seasonally-flooded wetlands, it may displace native marsh vegetation that produces more abundant food for waterfowl.

Grasslands and Savannas

Grasslands and savannas suffer the greatest concentrations of non-native species. Common in these areas are yellow starthistle (*Centaurea solstitialis*), medusahead (*Taeniatherum caput-medusae*), mustards *(Brassica* spp.), filarees (*Erodium* spp.)*,* ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*)*,* wild oats (*Avena* spp.)*,* ryegrasses (*Lolium* spp.), Mediterranean barleys (*Hordeum* spp.), non-native fescues (*Festuca* spp.), and bur-clover (*Medicago polymorpha*). A few of these species are particularly problematic. Yellow starthistle is of special concern because it degrades waterfowl nesting habitat in grasslands and savannas. Purple starthistle (*Centaurea calcitrapa*) was recently found on the Preserve, but only in small isolated patches. It bears floral spines even longer than those of yellow starthistle, and if it were to invade widely, it could present a threat similar to yellow starthistle.

Trails, Roads

Weeds that interfere with road and trail uses include yellow starthistle and Himalayan blackberry. Yellow starthistle, with its spiny flowerheads, can be an obstruction and annoyance on dirt roads and trails, and may also become a fire hazard once the annual stems die. Yellow starthistle and fennel colonize adjacent grasslands and waterfowl nesting habitat from trails and levees. Himalayan blackberry obstructs movement along trails.

2. Overview of Weed Management Plan

A. Management Philosophy and Setting Priorities: An Adaptive Management Approach

Some weeds may be tenacious and harmful while others may restrict themselves to recently disturbed locations. Attempting to control all the non-native species present can be overwhelming and ultimately unsuccessful, so we developed a strategy to ensure the most efficient use of resources. The strategy is built upon two principles. First, instead of managing against weeds, our philosophy is to manage for the target species and communities we desire. With this spirit, we identified weed species that threaten the survival of the desired conservation targets. Second, to minimize the total, long-term weed control workload we act to prevent new infestations and contain the spread of plants with expanding ranges. Therefore we identified those infestations that are the fastest growing, most disruptive, and affect the most highly valued area(s) of the site.

Then we set priorities for each species' control or elimination. These priorities reflected each weed's present or future harmful impacts. Control methods were determined by consulting with TNC's Wildland Invasive Species Program (WISP), preserve stewards, weed extension agents, and other experts. If leaving the weed unchecked would result in more damage than may be caused by controlling them, we developed appropriate control protocols. We also avoided control treatments during the summer months in areas where native or migratory nesting birds could be harmed. We gave higher priority to infestations we thought most likely to be controlled with available technology and resources.

We also noted species which are not yet on the preserve, but are found nearby and could be problems if they spread to the preserve. Our weed management program includes regularly monitoring the preserve for these species in order to quickly detect and eliminate them if they ever do appear.

In summary, we adopted an adaptive management strategy. An adaptive strategy is one that uses the lessons from previous seasons of work to mold future efforts. The various phases of our strategy are:

1. We establish management goals for the site.
2. The weeds interfering with these goals are identified and assigned priorities based on their impacts.
3. We determine effective control options. We assess the likely effects on the target (and non-target) species, and if necessary adjust the weed priorities.
4. We develop and implement the management plan.
5. We monitor and assess the impacts of our management actions.
6. We evaluate the effectiveness of our methods (measured against the site goals) and use this information to refine our control priorities, methods, and goals. We learn what is practical, effective, and realistic.

Return to step one...

B. Summary of Specific Actions Planned for the Cosumnes River Preserve

Control and monitoring programs planned for different habitats on the preserve are outlined below. Priorities for monitoring and controlling pest plant species are given in Table 1 (see "CRP-Tabl.xls" for Tables 1-5). High priority was given to plants that interfere with the most important management goals and whose populations are small and easiest to control now, before they spread. All listed species should be monitored at least every three years and mapped, if possible. Schedules for weed control are given in Table 2. Cost estimates for weed management are tabulated in Table 3.

Riparian Areas

We assigned high priority to eradicating fig, black locust, Osage orange, honeylocust, and tree of heaven from the preserve. We assigned high priority to monitoring for newly invading woody species. Chinese tallow tree (*Sapium sebiferum*) and Chinese wisteria (*Sesbania punicea*) have been seen along the Sacramento River, and would be serious problems on the preserve.

We assigned medium priority to prevent arundo from invading. We assigned medium priority to controlling fennel, low priority to monitoring blackberries, and medium priority to monitoring perennial peppergrass for indications it is expanding its range from wetlands into forested areas.

We will pull, cut, girdle, and/or apply herbicides to all individuals of the five high-priority tree species. All girdled or frilled trees will be left standing, except when the snags become a safety issue to humans. By leaving the dead trees standing, we reduce impacts to the surrounding vegetation, as well as create habitat for species that feed or nest in snags. To prevent arundo from invading we will work with neighbors to remove it from the Franklin Boulevard bridge site. We will control fennel infestations by the Visitor Center, along the Willow Slough Trail, and in Lost Slough, Willow Slough and other riparian areas. It does not interfere with management goals when present along the major roads through the preserve, and we believe the costs of controlling it there would outweigh the benefits of reducing the chances of re-introduction from these locations.

We are uncertain whether we should control blackberries. A rigorous study of this issue would be helpful, but is difficult for three reasons: 1) both native and exotic species are present; 2) identifications of the species are sometimes difficult, in part

because they apparently hybridize; 3) the plants, even the non-natives, provide benefits such as cover and forage for native (especially bird) species. Simple investigations conducted by staff and volunteers could help determine if the various blackberry populations are spreading, and their impacts on the recruitment of valued riparian species.

Wetlands

We assigned medium priority to controlling water hyacinth and to containing and monitoring perennial peppergrass populations. Water hyacinth will be controlled by hand-removal and herbicide applications. Treatments will be carried out in cooperation with the Sacramento-San Joaquin Delta Boats and Waterways Program. We will begin containment efforts and continually monitor perennial peppergrass to determine if it is spreading in the wetlands and forest edges.

Grasslands and Savannas

We do not know how to control the many invasive species in the grasslands or restore native grassland at a reasonable cost. Control programs for these areas will, therefore, be limited to adapting land use practices that maintain or improve the waterfowl nesting habitat and which favor native species over non-natives.

We assigned high priority to preventing purple starthistle from invading. We will search for and remove purple starthistle annually. We assigned low priority to monitoring yellow starthistle. We will monitor it in waterfowl nesting habitat and in grazing areas to learn more about its range on the preserve and if it can be controlled. We will control yellow starthistle around the Visitor Center and trailheads—see below—but not elsewhere; it is extremely widespread throughout the region.

Trails, Roads

We assigned high priority to controlling yellow starthistle along trails, dirt roads and around the Visitor Center. Yellow starthistle uses areas of such high disturbance as pathways to colonize new habitats. We assigned low priority to controlling blackberries along trails or dirt roads.

We will control yellow starthistle along all roads and trails adjacent to significant nesting habitat, along the Willow Slough Trail, all drivable levees, and around water control structures. Treatments may include cutting, grazing, prescribed burning or flame torching, and/or herbicide applications. We will prune blackberries along the Willow Slough Trail.

Other Species to Watch For

Smooth-leaved elm (*Ulmus minor*) appears to be spreading vegetatively near the farmhouse at the corner of Desmond and Bruceville Roads. It is not a problem at this time, but we will check to make sure it is not spreading beyond this patch. Poison hemlock (*Conium maculatum*) is toxic to humans. We may remove specimens from around the visitor center and produce a warning brochure on the species. Isolated seedlings and saplings of Wych elm (*Ulmus glabra*) have recently been found on the Preserve, and should also be monitored for spread. If it is spreading, it should be given high priority for eradication.

Inventory, Monitoring, Education

We are educating the preserve's volunteers (e.g. Habitat Restoration Team, Point Reyes Bird Observatory, etc.) to map and otherwise note weed populations as they conduct other work. This will serve both to monitor known weed populations and act as an early warning system for new invasions by honeylocust, pampas grass, arundo, purple starthistle, or other species.

It is important to know the distributions of the weed species on the preserve. It will allow us to monitor the spread of each species and the efficacy of the weed control tactics we use. Blank survey maps have been included. These should be photocopied and the distribution of each weed should be mapped. Sample maps for yellow starthistle and perennial peppergrass from 1996 are included as examples.

Using the survey maps generated by the staff and volunteers, the effectiveness of previous years' control measures will be examined and refined each January. This meeting will be used to plan the weed control measures to be implemented over the next year.

C. Management Tables

The tables in the Excel spreadsheet "CRP-Tabl.xls" outline how we will implement our weed management plan. Table 1 lists the weed species and their priority for control efforts. Table 2 contains the schedule of implementation for weed control. Note that prior to each growing season, the upcoming year's control efforts must be scheduled (in winter) while taking into account results from the previous year. Table 3 estimates the costs in money and time that will be incurred to carry out the plan for the next 4 years. Table 4 is an accounting sheet that records the actual costs for the weed management program. Each species

will have its own itemized account for resource costs each year. Table 5 allows us to calculate the differences between the projected (Table 3) and actual (Table 4) resource costs per year for use in future management planning.

3. Specific Weed Control Plans

Anticipated woody invaders (species not yet on the site but found nearby)

Priority: High (in all areas)—*Sapium sebiferum* (Chinese tallowtree), and *Sesbania punicea* (Chinese wisteria), and can infest riparian areas and interfere with primary management goals. Identifying and eradicating new infestations before they become entrenched is the most cost-effective weed management strategy, and so we give this strategy high priority in all areas of the preserve.

Description

These plants are escaped horticultural woody species. *Sapium sebiferum* is a tree similar in form to a poplar, and which bears white, popcorn-like fruit. Unlike poplars, it has white milky sap (it is in the euphorbia family). *Sesbania punicea* is a small leguminous tree with woody seedpods and bright, reddish pea-like flowers.

Current Distribution on the Preserve

Sapium sebiferum and *Sesbania punicea* have not yet been observed on the preserve, but would be serious problems if the became established.

Measurable Objectives and Goal

Goal: Detect any established plants and eradicate

(1) Continue yearly surveillance for new invasions of *Sapium sebiferum and Sesbania punicea*

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Hand-pull all seedlings, or use a weed wrench to remove saplings.
(2) If mature trees are found, cut them and treat the stumps with an herbicide. Frilling may also be used.

Treatment Schedule

April–May: Locate and remove all seedlings of these woody species in the Preserve's riparian areas. Record location with GPS.

Fall: Treat mature trees. Record location with GPS. Revisit prior locations to ensure successful eradication has been achieved.

Cost Estimates

Monitoring these species will require monitoring and removal (1 staff x 8 hrs; 10 volunteers x 6 hrs), and resprout control (1 staff, 8 hrs). Costs are low because this can be done at the same time as similar work for other tree weeds.

Annual costs are estimated at $30- fuel and $15- refreshments for volunteers.

Riparian invasive tree species

Priority: High (in riparian areas)—*Ailanthus altissima* (tree of heaven), *Ficus carica* (edible fig), *Gleditsia triacanthos* (honeylocust), *Maclura pomifera* (Osage orange), *Robinia pseudoacacia* (black locust), *Ulmus minor* (smooth-leaved elm), *Ulmus glabra* (Wych elm), and *Morus alba* (white mulberry),can infest riparian areas and interfere with primary management goals. The populations of these trees are still small and it is still possible to extirpate them.

Description

These plants are escaped horticultural woody species that thrive in the wet forested areas of Cosumnes River Preserve.

Current Distribution on the Preserve

Complete surveys have not been completed, but the following populations are known: *Ailanthus altissima*—Valensin, Willow Slough and the railroad tracks; *Ficus carica*—at least four stands in the Tall Forest; *Gleditsia triacanthos*—Valensin and Tall Forest; *Maclura pomifera*—Valensin and Tall Forest; *Robinia pseudoacacia*—Valensin and near the barn and farmhouse; *Ulmus glabra*—young plants have been found in Valensin; *Morus alba*—one mature tree has been found in Valensin. *Ulmus minor* appears to be spreading vegetatively near the farmhouse at the corner of Desmond and Bruceville Roads. This is not in a riparian area, but it may act as a seed source.

Measurable Objectives and Goals

Goal: Eradicate

(1) Locate and map all specimens on the preserve.
(2) Eradicate existing plants within three years
(3) Continue yearly surveillance. Consider restoration at areas of dense infestations if they do not recover within three years.

These species may resprout following cutting, or girdling, especially if they are not treated with herbicides. To minimize this, trees will be treated with herbicides, preferably triclopyr or glyphosate plus dye. Cut stump or hack & squirt treatments may be used against any size tree. Basal bark treatments are effective only on young, thin-barked trees. Foliar spray treatments can be used against small trees, but this method has the highest potential for herbicide drift and resultant injury to non-target vegetation.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Hand-pull or weed wrench all seedlings and saplings.
(2) Cut any mature trees and treat the stumps with an herbicide. Frilling, in conjunction with herbicides, may also be preferred for *Ailanthus* and *Robinia* because these species resprout vigorously when cut. Glyphosate or triclopyr are effective.

Treatment Schedule

April–May: Locate and remove all seedlings of these woody species in the Preserve's riparian areas. Create survey maps using blanks copied from the Appendix. Record locations with a GPS unit if possible.

Summer-Fall: Treat mature trees. Avoid treatment during summer months in areas where nesting birds occur. Leave snags if they provide useful nesting habitat, and do not endanger personnel. Treat *Ficus carica* one month before leaf drop for maximum effectiveness. Foliage of *Maclura pomifera* is bright yellow in the fall, and additional plants could be detected this way.

Cost Estimates

Controlling invasive trees will require an estimated 232 hours of staff time and 900 hours of volunteer labor for the first year. This includes estimates for initial monitoring (1 staff x 8 hrs x 5 d, 10 volunteers x 6 hrs x 3 d), control work (2 staff x 8 hrs x 8 d, 10 volunteers x 6 hrs x 8 days), and follow-up control/monitoring (2 staff x 8 hrs x 4 d, 10 volunteers x 6 hrs x 4 d). These estimates will drop by 30% in each successive year.

Yearly costs for materials are estimated as follows: herbicide- $275 the first year (reduced by $80/year); protective gear- $238/year (35 tyvek suits - $210, gloves - $28); fuel - $210/year, and refreshments for volunteers- $420 (reduced by $120/year). The costs of restoration work have not been estimated.

Arundo donax (Giant Reed or Arundo)

Priority: Medium (in riparian areas)—arundo can infest riparian areas and interfere with primary management goals. The Franklin Boulevard population adjacent to the preserve should be removed before it spreads to the preserve.

Description

Arundo is a rhizomatous perennial cane-like grass with light green leaves that diverge from the stem in a distinctive herringbone pattern. It grows up to 8 m tall in riparian areas, seeps and ditchbanks.

Current Distribution on the Preserve

Riverbank on land adjacent to the preserve—the south side of the Mokelumne River by the Franklin Boulevard bridge.

Measurable Objectives and Goal

Goal: Prevent establishment on the preserve.

(1) Locate and remove all arundo on the preserve and continue surveillance for new invasions.
(2) Eradicate the patch on the south side of the Mokelumne River by the Franklin Boulevard bridge within two years.
(3) Influence the Department of Water Resources to prevent the spread of arundo when building new levees near the preserve.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Work with neighbors and the Department of Water Resources to eliminate the population or at least prevent its spread during the construction of the new Thornton levee by first cutting and safely removing or burning it, then applying herbicide to cut stems and later to resprouts.

The most effective herbicidal treatment of arundo is a foliar application of 2-5% solution of Rodeo, applied post-flowering but pre-dormancy. This is usually mid-August to early November.

Treatment Schedule

January: Develop a plan with the neighbors to cut, apply herbicide, and/or safely remove the Franklin Boulevard bridge infestation. Contact the Department of Water Resources to control any other arundo infestations prior to re-construction of the Thornton Road levee.
April–May: Locate any new infestations. Create a survey map using blanks copied from the Appendix.
August–November: treat arundo.

Cost Estimates

It will require approximately 4 hours for 1 staff member to meet with the property owner and the Department of Water Resources staff regarding control of arundo by the Franklin Blvd. bridge. Surveying the preserve for infestations is estimated to require 4 hours of staff time and 15 hours volunteer time (5 volunteers, 3 hours) annually. Annual costs are estimated at $10 for fuel and herbicide, and $15 for refreshments for volunteers.

Centaurea calcitrapa (Purple Starthistle)

Priority: High (in grassland areas)—Purple starthistle has only been found in a few small, isolated patches on land near the Preserve. If it establishes itself on the preserve it may rapidly spread into large infestations, and would then be very difficult to control. The threats posed by this species are likely to be similar to those of yellow starthistle.

Description

Annual or perennial herb in the sunflower/thistle family (Asteraceae). Young rosettes bear pinnately-lobed leaves up to 30 cm. long. It bolts in late spring producing purple flowers in dense heads surrounded by bracts with stout spines up to, and exceeding, 25 mm long.

Current Distribution on the Preserve

Purple starthistle has not yet been located on the preserve but it is distributed at nearby sites in the Central Valley, including the nearby Jepson Prairie Preserve.

Measurable Objectives and Goal

Goal: Detect purple starthistle as soon as it arrives on the preserve. Prevent it from being transplanted unintentionally to the preserve.

(1) Locate and remove any purple starthistle on the preserve twice every summer prior to seed production.
(2) Establish a protocol to clean equipment that is used in areas off the preserve that may be infested with purple starthistle.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Pull or dig out plants when infestations are first detected.
(2) Clean any fire equipment that may be used at Jepson Prairie, prior to its returning to the Cosumnes River Preserve.

Treatment Schedule

June: Survey for new infestations, and create a survey map using blanks copied from the Appendix. Use any of the management options to remove all purple starthistle prior to seed production both on the Preserve and, if possible, in areas adjacent to the preserve. All treated plants will be monitored and re-treated every four weeks until they are eliminated.

Cost Estimates

Monitoring and controlling purple starthistle will require an estimated 8 hours staff time and 6 hours volunteer time annually. Estimated annual costs include $20 for fuel and $15 for refreshments.

Centaurea solstitialis (Yellow Starthistle)

Priority: High (trails & Visitor Center), low (grassland areas)—High priority has been assigned to removing unsightly infestations around the Visitor Center and along trails, which it can use to invade new areas. It interferes with primary management goals in grasslands by diminishing waterfowl nesting habitat, but the infestation is too large to eradicate with available technology.

Description

Annual taprooted herbaceous plant in the sunflower/thistle family (Asteraceae). It can grow up to 1 m tall with distinctive gray-green leaves and stems and yellow flowerheads surrounded by spiny bracts. It produces abundant seed each year.

Current Distribution on the Preserve

Extensive populations throughout the preserve's Savanna areas, along the trails, and near the visitor center. Other units containing populations of yellow starthistle are shown in the Appendix sample maps.

Measurable Objectives and Goal

Goal: The yellow starthistle infestation is extensive in and around the preserve, and cannot be eradicated with available technology. Instead, our objectives are:

(1) Eradicate the pest along all roads and trails that lead to uninfested areas.
(2) Reduce infestations along the Willow Slough trail, especially at the trailhead and near the visitor center.
(3) Determine the extent of the infestation on the preserve and the value of controlling it in grasslands and savannas, especially in areas where waterfowl nest.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Hand pull plants where infestations are small.
(2) Spot treat infestations with clopyralid with an added dye early in the growing period.
(3) Clean vehicles before entering uninfested areas.

The yellow starthistle infestation is extensive. Lesser-priority areas will have to be neglected. Highest priority will be given to reducing new outbreaks and to removing the plant from currently infested roads and trails that lead to uninfested areas.

One or more of the following methods may be used prior to seed production: early season herbicide application (clopyralid), repeated mowing/weed whacking, hand pulling. Cutting effectively reduces seed production if plants are cut when about 2% of the flower heads have opened, and then again 4-6 weeks later.

Treatment Schedule

June: Map and monitor infestations (see Monitoring, below) to act as an early warning system for new colonies as they develop, and to determine population trends.
June-July: Cut or apply herbicide when 2% of the flower heads have opened.

Cost Estimates

The costs and labor needs for controlling yellow starthistle in grassland areas have not yet been estimated. Controlling yellow starthistle by the Willow Slough trailhead and the Visitor Center will require an estimated 16 hours of staff time, 60 hours of volunteer time, and $45 annually. This includes estimates for mapping and pre- and post-treatment, refreshments for volunteers, some control efforts, and monitoring.

Eichhornia crassipes (Water Hyacinth)

Priority: Medium (in wetland areas)—Water hyacinth infests sloughs and other open-water wetland areas and interferes with primary management goals. Even if eliminated from the preserve, it would quickly reappear because it is widespread in the Sacramento-San Joaquin Delta. It can, however, be controlled seasonally and kept from infesting more sloughs on the preserve.

Description

An aquatic plant with glossy, floating leaves up to 10 cm wide supported on bulbous petioles. Its showy, lilac-colored flowers are produced on a spike that sticks up above the leaves.

Current Distribution on the Preserve

Primarily in Lost Slough, particularly during the summer and fall.

Measurable Objectives and Goal

Goal: Reduce the water hyacinth in Lost Slough, and prevent its spread.

(1) Locate all water hyacinth on the preserve each summer and continue surveillance for new invasions in perpetuity.
(2) Reduce summer peak cover to a maximum of 10% absolute cover in any 500 meter slough section, every year.
(3) Prevent the plant from spreading to other preserve wetlands.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Use a boom to prevent the plants from floating into Lost Slough.
(3) Manually remove plants from Lost Slough.
(4) Coordinate with and guide the control actions of the State Boats and Waterways Program and associated agency staff.
(5) Apply acetic acid or herbicide/adjuvant certified for use over water to foliage.
(6) No treatment.

Treatment Schedule

June–September: Locate, treat, and remove all new water hyacinth infestations in preserve water channels monthly. Find and map water hyacinth on the preserve. Construct an experimental boom across Lost Slough to prevent new influxes of the weed from entering.

Treat water hyacinth in Lost Slough each summer in cooperation with the State Boats and Waterways Program and associated agency staff (e.g., Sacramento County Vector Control) who oversee control in the Sacramento-San Joaquin Delta. Inform agency staff they may not spray herbicides aerially on the preserve. Water hyacinth could be removed by a contractor using excavators, but it would cost at approximately $5000, and the likelihood of reinfestation makes this option unattractive. The simplest control would be via manual removal using work parties, combined with some herbicide or acetic acid use.

Cost Estimates

Water hyacinth would require an estimated 24 hours of staff time, 220 hours of volunteer time, and $140 annually. An initial annual workday (2 staff x 8 hrs, 20 volunteers x 8 hours, $100 for fuel and refreshments) would attack the main infestations along the slough waterways and by the booms. Additional monitoring would require 8 hours staff time and 60 hours volunteer time for monitoring annually, and $40 for refreshments.

Foeniculum vulgare (Fennel)

Priority: Medium (in riparian areas)—Fennel interferes with primary management goals in riparian communities and is considered a visual blight around the Visitor Center and on the Willow Slough Trail. It forms monospecific patches that likely prevent recruitment of riparian species. The relatively small, slowly expanding populations in important areas may be easily controlled with herbicides. Roadside populations are not a threat to management goals at this time.

Description

A perennial, anise-scented, taprooted herb up to 2 meters tall with very finely divided leaves. Flowers in mid-summer.

Current Distribution on the Preserve

Fennel occurs along the first leg of the Willow Slough Trail, in one large patch on the edge of the Willow Slough and Lost Slough riparian communities, by the Visitor Center, and along Franklin Boulevard and Interstate-5.

Measurable Objectives and Goal

Goal: Eradicate patches along the Willow Slough Trail, on the edge of Willow Slough and Lost Slough, and near the Visitor Center.

(1) Monitor for new infestations.
(2) Eradicate fennel infestations by the Visitor Center, along the Willow Slough Trail and other riparian areas within three years.
(3) If the post-eradication area does not have natural vegetation four years after fennel removal, consider restroation replantings.
(4) Within five years determine the need and ability to control non-riparian populations of fennel on the preserve.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Cut or burn fennel. Two to four months later, apply a wetland-certified herbicide/adjuvant with dye to all regrowth.
(2) Cut repeatedly.

The most successful method known is to treat with triclopyr or glyphosate in March–April when regrowth is 0.3–0.6 m tall. Both Garlon 3A (2% concentration with 0.5% non-ionic surfactant) and Garlon 4 (1.5% concentration) are effective. Concentrations as low as 1% Garlon 3A or 0.75% Garlon 4 may also be effective when applied thoroughly in spot treatments. Glyphosate was also reported to be effective when sprayed (2% Roundup) and brushed on (100% Roundup). It controlled plants under 0.3 m tall, plants that were cut and immediately treated, and regrowth sprayed 1–2 months after canes were cut. Where herbicides are used, signs should be posted warning visitors not to touch or eat the plants. It may be useful to cut or burn old canes during the late fall when they are dormant.

Mowing fennel yearly reportedly reduced infestations over time on property adjacent to the preserve. Flame treatments will require repeat applications. Combinations of techniques may also be effective.

Treatment Schedule

June–August: Locate and map all fennel infestations in riparian areas using blanks copied from the Appendix.
October–November: Cut plants by the Visitor Center, along Lost and Willow Sloughs and on the Willow Slough Trail.
March–April (Year #2): Treat resprouts from populations cut in October-November with triclopyr or glyphosate.
May, July, September (Year #2): Check treated areas every two months and re-treat all new sprouts until the plants are killed.

Cost Estimates

Controlling fennel will require an estimated 52 hours staff time and 174 hours volunteer labor in the first year, diminishing by 50% yearly from the preceding year for each of the next two years, then dropping to only the 8 hours staff time needed for mapping in the 4th and 5th years. First year work includes mapping (1 staff x 4 hrs), cutting by the Visitor Center and Willow Slough Trail, and in the Willow Slough and Lost Slough riparian communities (1 staff x 8 hrs; 10 volunteers x 6 hrs), post-cutting treatments (2 staff x 8 hrs; 10 volunteers x 6 hrs), and final follow-up monitoring and treatments (3 staff x 8 hrs; 9 volunteers x 6 hrs).

Annual estimated costs for the first three years include use of herbicide, and/or flame equipment and materials ($35 for each of the first three years), and refreshments for volunteers ($75 the first year, then reduced by half yearly). The costs will drop to 0 in the 4th and 5th years. The costs of restoration work have not been estimated.

Lepidium latifolium (Perennial Peppergrass)

Priority: Medium (in riparian areas and wetland areas)—Perennial peppergrass is scattered throughout riparian and seasonal wetland areas of the preserve and may interfere with primary management goals for these areas. In riparian areas, it is rare under forest canopy. It may also interfere with agriculture goals if it invades rice fields. We do not know whether populations are spreading or stable or how difficult it will be to control. Valley Oaks might have a higher survival rate when planted among perennial peppergrass then among annual grasses.

Description

A perennial rhizomatous herb in the mustard family that grows up to 2 m tall in dense stands. Tiny, four-petaled white flowers are produced in clusters near the ends of branches. Basal rosette leaves are up to 37 cm long and 8 cm wide, while stem leaves are only up to 10 cm long.

Current Distribution on the Preserve

The most extensive infestations occur along the Lost Slough Riparian Corridor and by the Visitor Center. A map of the weed's distribution on the preserve is included in the Appendix. Areas east of the Cosumnes River have not been surveyed.

Measurable Objectives and Goal

Goal: Determine the threat posed by perennial peppergrass, and begin containment efforts.

(1) Locate and monitor perennial peppergrass infestations on the preserve and continue surveillance for new invasions.
(2) Determine if perennial peppergrass populations are changing (defined as an absolute cover change or range expansion of at least 30% in five years), if new colonies are forming, and the effect of perennial peppergrass on riparian trees.
(3) Begin control efforts by mowing test plots in early summer, to be followed by herbicide application in late summer. Expand this program if it is demonstrably successful.

Control Options

Control options may be used only with the permission of the appropriate landowner and compliance with applicable environmental regulations. The Cosumnes Preserve Manager is responsible for meeting these requirements and approving any trained staff or certified pesticide applicators who will handle herbicides. He/she should be consulted before actions are taken. Staff in charge are responsible for assuring that all participants are trained in the proper handling of tools and materials.

(1) Cut, pull, mow repeatedly, and/or use a weed whacker.
(2) Mow, then apply herbicide.

Treatment Schedule

June–August: Map perennial peppergrass every three years.

Summer: Mow infestations in early summer, and spray herbicide (Telar) in late summer.

Cost Estimates

Investigating population trends and control of perennial peppergrass will require an estimated 80 hours of staff time and 100 hours of volunteer time in the first year, dropping to 48 hours staff time and 100 hours of volunteer time in each of the subsequent years. This includes the first-year exploratory investigations of impacts on riparian trees (data collection: 1 staff, 60 hrs; 5 volunteers, 20 hrs; analysis: 1 staff, 20 hrs), and four years of continued monitoring, mapping, and containment of the weed.

Estimated annual costs include the mowing and containment of the weed, and considers maintenance and equipment costs ($1,500/yr for materials, fuel, protective gear, and/or herbicide), and the cost of refreshments for volunteers.

Rubus armeniacus (Himalayan Blackberry)

Priority: Low (in riparian areas)—Himalayan blackberry (also known as *R. discolor* and *R. procerus*) is vigorous and troublesome and can grow in riparian areas. It also has characteristics that may be beneficial to some species (particularly birds) and we are uncertain if it is a net asset or liability to our riparian areas. We are uncertain of the effects of these blackberries on native blackberries and other species. Native tree seedlings may be shaded out under Himalayan blackberry, especially in stands covered by the native wild grape. There may also be another non-native blackberry on the preserve, *R. pensilvanicus* (loganberry). *R. armeniacus* and *R. pensilvanicus* may hybridize with each other and with the native *R. ursinus* (Californian blackberry). More study is needed on blackberry (and its hybridization potential) before we can make further decisions on its control.

Description

Himalayan blackberries are prickly, bramble-forming perennial shrubs. They are common in disturbed moist areas and along roadsides and fencerows. Distinguishing among the *Rubus* species and hybrids at Cosumnes can be difficult.

Himalayan Blackberry: a) 5-angled stems 0.5–1.7 cm in diameter, often reddish, with wide, curved prickles, b) compound leaves comprised of 3-5 toothed leaflets that are generally widest above the middle and have white undersides, and c) oblong fruit.

Logan Blackberry: Similar to *Rubus armeniacus* (stout 5-angled stems with wide, curved prickles and leaves with 3-5 leaflets and toothed margins), but the flowers are in racemes rather than in panicles (as in *R. armeniacus*).

California Blackberry: a) round stems 0.25–1.3 cm in diameter, with more numerous slender straight prickles, b) compound leaves comprised mostly of 3 lobes or distinct leaflets that are widest below the middle and have green undersides, and c) oblong to spheric fruit.

Current Distribution on the Preserve

Distributed throughout riparian areas, including Lost Slough, Willow Slough, the Cosumnes River (Bottomlands, Tall Forest, and Cougar Unit), the road connecting Wood Duck Slough with the Tall Forest, and other areas.

Measurable Objectives

(1) Determine if Himalayan blackberry and loganberry are spreading.

Control Options

(1) Have 1-2 staff members learn to identify Himalayan and California blackberry and hybridized variants within 1-2 years.
(2) Monitor blackberry cover changes in the Tall Forest, Lost Slough, and Willow Slough riparian communities annually.

Schedule

June–August: Map the entire preserve for non-native blackberry species. Where possible distinguish *R. armeniacus* from *R. pensilvanicus.* Use blanks copied from the Appendix. Establish line transects in Tall Forest, Lost Slough, and Willow Slough areas.

Cost Estimates

The cost estimates only reflect the cost of monitoring the blackberries on the preserve. 16 hours of staff time and 72 hours of volunteer labor each year. This includes time to map and monitor the entire preserve (2 staff x 8 hrs, 12 volunteers x 6 hours).

Yearly costs for materials are estimated as follows: $50 for refreshments for volunteers.

Appendix 1. Emergency Information/Map to Hospital (updated 12/00)

IN CASE OF EMERGENCY

Cosumnes River Preserve
13501 Franklin Boulevard
Galt, CA 95632

(Note: Dial 9 first to call off of the Preserve):
If you are calling from the Preserve and the operator asks for your number, the phone number you are calling from is listed on the phone (generally as Line 1).

Ambulance—(9)-911
CALTIP—(9)-1-800-952-5400 (to report illegal hunting, fishing, dumping/pollution)
Fire—(9)-911
Highway Emergencies—(9)-911
Poison Control Center—(9)-1-800-876-4766 (24 Hour)
Police—(9)-911

NEARBY HOSPITALS**:**

SACRAMENTO AREA:

Methodist Hospital of Sacramento **(9)-423-3000 (emergency)**
15 miles north of the Preserve
At the corner of Bruceville Rd. and Timberlake Way (see map, next page)

Kaiser Permanente Medical Ctr. of So. Sacramento **(9)-688-2535 (emergency)**
(9)-688-2000 (operator)
15½ miles north of the Preserve
6600 Bruceville Rd.; Bruceville Rd. at Wyndham Way (see map, next page)

LODI AREA:

Lodi Memorial Hospital **(9)-1-209-334-3411 (emergency)**
18 miles south of the Preserve
975 South Fairmont Ave.; just south of West Vine St. (see map, next page)

OTHER SACRAMENTO HOSPITALS (FURTHER AWAY):

U.C. Davis Medical Center **(9)-1-734-3790 (emergency)**
(9)-1-734-2011 (operator)
On 2nd Street, off of Stockton Blvd. North of Broadway

Sutter General Hospital **(9)-1-733-3003 (24 hour emergency)**
Corner of L Street and 29th Street in downtown Sacramento

(see next page for map)

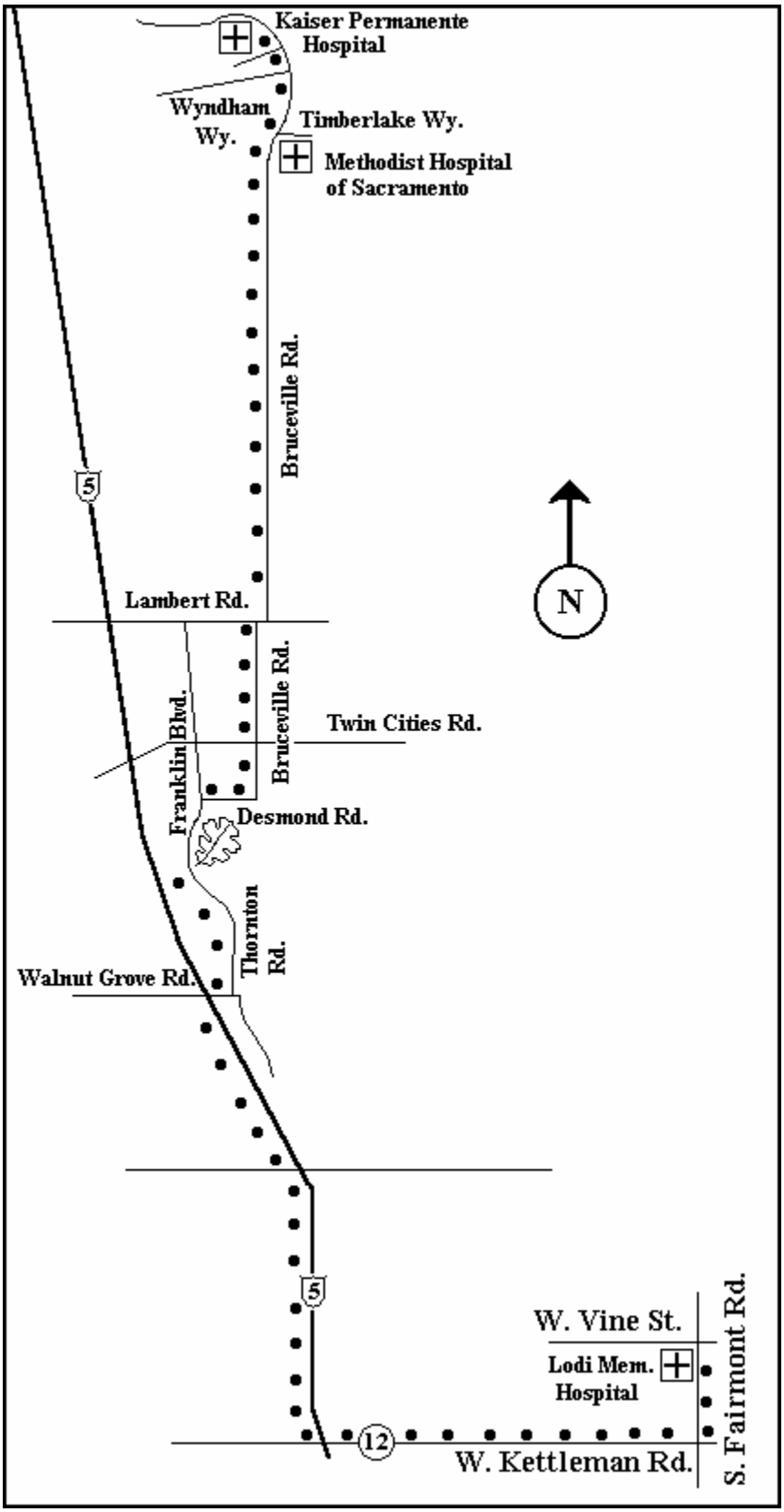


Figure 3: Hospital Directions

Appendix 2. Blank Maps/Sample Maps

Blank Maps/Sample Maps
Attach copies of the monitoring map(s) here.

Appendix 3. Herbicide Use Record Forms

When using herbicides it is critical (and, in many cases, required by law) to keep detailed records of all relevant information. Ideally, records would include data on the condition of the site prior to herbicide application, the type of species present, and percent cover of invasive and native species prior to application. This information will be valuable in evaluating the effectiveness of the herbicide. At the time of application, take detailed notes of the type and concentration of the herbicide, the amount, location, and method of application, weather conditions, and any other observations made during the course of application. This information is important in evaluating the project's success, improving methodology, and identifying mistakes. In addition, it documents the procedure for future site managers and biologists. As in Appendix 2, you may use "TNC's Policy, Procedures, and Guidelines for Use of Herbicides…"

Appendix 4. Herbicide Use Protocols

Herbicide Labels
Attach copies of the herbicide label(s) here.

Appendix G

Best Management Practices

Individual implementation guidelines for

- green roofs
- parking area design
- bioswales
- filter strips/level spreaders
- naturalized detention
- porous pavement
- rain barrels/cisterns
- rain gardens
- vegetated swales
- use of native plants for landscaping

Rain Garden

Definition

- A rain garden is a landscaped garden designed to retain and detain stormwater runoff from individual lots and roofs. These gardens are designed to catch water, allowing most of it to infiltrate into the ground. By minimizing the amounts of stormwater going into local storm drain systems, rain gardens help to reduce the chances for local flooding, as well as bank and shoreline damage where storm drains empty into streams and lakes.

rainwater garden planted with vegetation that attracts butterflies (Maplewood, MN)

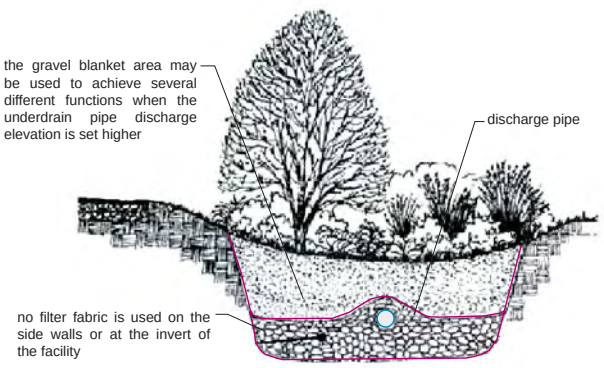
Benefits

- Reduces runoff volumes and rates from lawns, roofs, and driveways.
- Recharges groundwater and sustains base flows.
- Reduces sediment and nutrient runoff.
- Reduces pollution in nearby streams and lakes.
- Can reduce detention needs.
- Can increase aesthetic value for the properties.
- Can provide wildlife habitat.
- Can reduce the need for costly municipal water treatment structures

roof top down spout connects to rainwater garden (Glen Ellen, IL)

Design Considerations

- Rainwater gardens must be sized and designed based on drainage area, soils, and desired runoff volume reduction.
- Filtration and nutrient control benefits can be improved by planting native vegetation.
- The soils in the top 18″ to 24″ should be amended with leaf compost and coarse sand to enhance organic content and improve permeability.
- Where subsoil infiltration rates are low (less than 0.5 to 1.0 in/hr), a gravel trench with underdrain should be used to encourage drainage between events.
- Maximum ponding depths should generally be limited to 6″ to 12″ unless underdrains are used.



rainwater garden cross section (Low Impact Development Center)

Rain Barrel/Cistern

Definition

- Rain barrels and cisterns are vessels used to capture and temporarily store rainwater for various uses, including greywater reuse and irrigation. By storing and diverting runoff from impervious areas such as roofs, these devices reduce the undesirable impacts of runoff that would otherwise flow swiftly into receiving waters and contribute to flooding and erosion problems. Rain barrels are typically used for residential applications, where as cisterns are typically used at large scale sites.

rain barrel in the back yard (Conservation Design Forum)

Benefits

- Reduces runoff volumes.
- Conserves water for greywater reuse.
- Provides irrigation water during watering restrictions.

a cistern system collects rainwater from Chicago Center for Green Technology (Chicago, IL) (Photo: Conservation Design Forum)

Design Considerations

- At the residential scales, rain barrels located at downspouts will typically be used.
- One inch of rainfall over 1,000 square feet of roof area is equivalent to 625 gallons of rainwater.
- Rain barrels can be used in combination with rain gardens, green roof, and other stormwater BMPs to increase stormwater benefits.
- Larger cisterns in some settings may be used to provide greywater for use in toilet flushing and other non-portable uses.

Filter Strip/Level Spreader

Definition

- A filter strip is an area with dense, preferably native vegetative cover used to filter and absorb runoff from impervious areas. A level spreader is a trench laid on the contour to distribute runoff over planted areas. Typically, level spreaders spread water over gently sloped, natively planted areas or filter strips in order to reduce the speed of the water and increase infiltration.

Coffee Creek Center level spreader installation (Chesterton, IN)
(Conservation Design Forum)

Benefits

- Reduces runoff volumes and rates by allowing runoff to infiltrate over a large area.
- Recharges groundwater and sustains base flows.
- Reduces sediment and nutrient runoff.
- Deconcentrates runoff from storm sewers and detention basins to dissipate energy, reduce scour, and better mimic historic runoff patterns of receiving waterbody.
- Can reduce detention needs.

filter strips/level spreader

Design Considerations

- Filter strips/level spreader must be sized and designed to account for drainage area, slope and soils. Chronic hydraulic overloading of filter strips may cause erosion and sedimentatino problems.
- Filtration benefits can be improved by planting native deep-rooted vegetation and by minimizing the slope.
- Infiltration storage within the level spreader trench should be designed to drain in 24 to 48 hours to prevent sealing of subsoils.
- Compaction of filter strips should be avoided and/or topsoil should be amended with leaf compost and coarse sand to improve filtration, infiltration and plant establishment.
- Runoff should be diverted away from filter strips during construction activities until vegetation is established.

Vegetated Swale

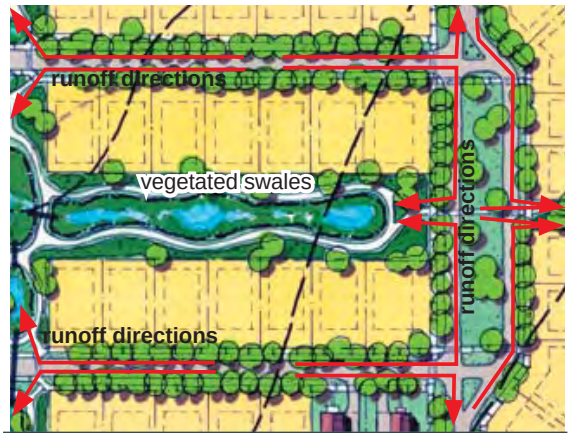
Definition

- Vegetated swales are planted stormwater features that convey, retain, infiltrate, and cleanse stormwater. They serve to remove sediment, nutrients and other contaminants, increase infiltration, and beautify the development.

vegetated swales planted with native grasses and forb along the street

Benefits

- Reduces runoff volumes and rates.
- Provides conveyance and water quality benefits in one stormwater feature.
- Reduces sediment and nutrient runoff.
- With proper design, can reduce detention needs.
- Densely rooted native grasses and forbs can provide permanent stabilization.



schematic plan of back yard vegetated swale system
(Conservation Design Forum)

Design Considerations

- Vegetated swales must be sized to convey design runoff rate (typically 10-year storm).
- Filtration benefits can be substantially improved by planting native deep-rooted grasses and forbs and by minimizing the slope.
- Topsoil may be amended with compost and/or coarse sand to improve organic content for filtering and to improve infiltration and retention of runoff.
- Vegetated swales should be protected from construction site runoff to prevent sealing of topsoil and/or subsoils.

back yard vegetated swales

BIOSWALE

Definition

- A bioswale is a vegetated swale system with an infiltration trench designed to capture and temporarily store stormwater. Bioswales are planted with native grasses and forbs that enhance filtration, cooling, and cleansing of water in order to improve water quality and prevent sealing of subsoils.

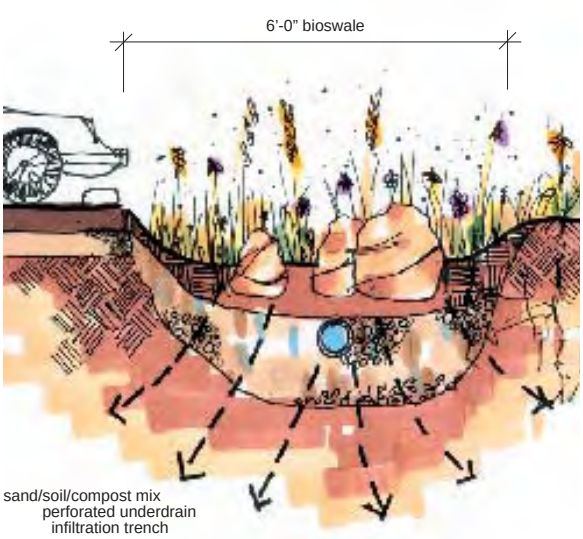
Benefits

- Reduces impervious runoff volumes and rates.
- Recharges groundwater and sustains base flows.
- Reduces sediment and nutrient runoff.
- Can reduce detention needs.

Design Considerations

- Bioswales must be sized and designed to account for drainage area and soils.
- Filtration benefits can be improved by planting native deep-rooted vegetation.
- Infiltration storage should be designed to drain in 24 hours to prevent sealing of subsoils.
- Topsoil should be amended with compost and sand to improve organic content for filtering and to achieve adequate infiltration rates.
- Bioswales should be protected from construction site runoff to prevent sealing of topsoil and/or subsoils.
- Direct entry of stormwater runoff into infiltration trench should be prevented to protect groundwater quality and to prevent sealing of subsoils.
- Underdrain should be sufficiently low in the trench to provide adequate drainage of aggregate base of adjacent paved areas but sufficiently high to provide infiltration storage.

bioswale in a parking lot (Tellabs, Naperville, IL)
(Conservation Design Forum)



cross section of bioswale (Conservation Design Forum)

Porous Pavement

Definition

- Porous pavement is permeable or perforated paving materials or pavers with spaces that allow transmission of water to aggregate base and subsoils. Runoff is temporarily stored in the base for infiltration into the subsoils and/or slow release to a storm drain system. Porous pavement also filters some pollutants from the runoff.

porous pavement employed in driveway

Benefits

- Reduces runoff volumes and rates.
- Recharges groundwater and sustains base flow.
- Filters sediments and associated pollutants from runoff.
- Can reduce detention needs.
- Improves water quality while preserving water resources.

porous pavement allows infiltration through the paving material

Design Considerations

- Base and subbase materials should be coarse aggregate with no fines to allow adequate drainage and prevent frost heave.
- Subgrade should be graded at minimum 1% slope to allow drainage when water entry rate exceeds infiltration capacity of subsoils.
- Subsoils should be compacted to the minimum level necessary to achieve structural stability.
- Geotextiles should be used between base and subgrade to improve structural stability and separate base from subgrade.
- Underdrains should be placed at edge of pavement to provide drainage as necessary to prevent ponding in the base for periods greater than 24 hours.

porous pavement in parking lot

Naturalized Detention

Definition

- Naturalized detention basins are water detention areas planted with native vegetation. They are used to temporarily store stormwater runoff and release it at a rate allowed by ordinances. Both as detention basins (where the water drains out completely between storms) and as retention or wet basins (where water is minimally released), these facilities address stormwater quality. Native wetland and prairie vegetation is used to achieve water quality and habitat benefits.

Benefits

- Reduces runoff rates.
- Recognized by virtually all stormwater management agencies as an approved method of controlling stormwater runoff.
- Very effective at removing sediment and associated pollutants.
- Provides attractive site amenity when properly designed and not used as sole BMPs on sites with high pollutant/nutrient runoff.
- May reduce maintenance costs.

naturalized wetland detention in Tellabs industrial campus (Bolingbrook, IL)(Conservation Design Forum)

Design Considerations

- Should be sized to control release to allowable rate.
- Size should reflect use of upstream BMPs.
- Water level fluctuations should be limited to 3-4 feet (during 100-year storm) to maximize plant diversity.
- Shallow water entry angles will minimize shoreline erosion, improve water quality benefits, increase wetland habitat and plant diversity and provide safety ledge.
- May be used as retrofit along stream corridors to prevent direct discharge of stormwater runoff.

a well designed naturalized wet detention provides extra open space and resting place

Native Landscaping

Definition

- Native landscaping is the establishment of native vegetation in either large restoration projects or smaller gardening projects. Native landscaping is often a component of other BMPs such as naturalized detention, filter strips, bioswales, and rain gardens.

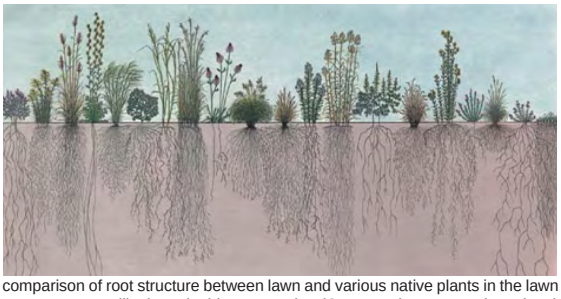
Benefits

- Reduces runoff volumes.
- Increases infiltration rates.
- Increases ability to remove nutrients.
- Increases organic content of soils.
- Increases permeability of compacted soils.
- Reduces irrigation and fertilization requirements.
- Reduces use of fossil fuels and air pollution relative to turf landscapes that require regular mowing and maintenance.
- Provides wildlife habitat.
- Can increase aesthetic value for property.

Design Considerations

- Some local "weed" ordinances may need to be amended to allow native and taller vegetation.
- Plant diversity and health is maximized by annual burning. Plots may be mowed and then burned to prevent spread of fire on small sites.
- On compacted soils, amendment may be necessary to increase organic content, improving success of establishment.

prairies planted in residential development area (Mill Creek, IL)



comparison of root structure between lawn and various native plants in the lawn
Illinois and Mid West Region (Conservation Research Institute)

Blackwell Prairie (IL)

Parking Area Design

Planting Strategies

Vegetation is an effective and attractive way to manage stormwater over large areas of paving. Bioswales are often used to help reduce parking lot runoff. A bioswale is a vegetated swale system with an infiltration trench designed to capture and temporarily store stormwater. Bioswales are planted with grasses and forbs that enhance filtration, cooling, and cleansing of water in order to improve water quality and prevent sealing of subsoils. These areas should be designed specifically to accept parking area runoff and to provide temporary storage and on site infiltration

Benefits

- Bioswales reduces impervious runoff volumes and rates.
- Bioswales recharge groundwater and sustains base flows.
- Bioswales reduce sediment and nutrient runoff as well as detention needs.

Design Considerations

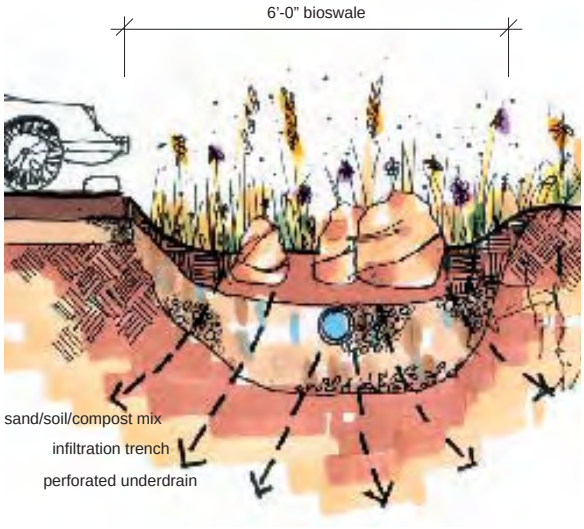
- Bioswales must be sized and designed to account for drainage area and soils.
- Filtration benefits can be improved by planting native deep-rooted vegetation.
- Infiltration storage should be designed to drain in 24 hours to prevent sealing of subsoils.
- Topsoil should be amended with compost and/or sand to improve organic content for filtering and to achieve adequate infiltration rates.
- Bioswales should be protected from construction site runoff to prevent sealing of topsoil and/or subsoils.
- Direct entry of stormwater runoff into infiltration trench should be prevented to protect groundwater quality and to prevent sealing of subsoils.
- Underdrain should be sufficiently low in the trench to provide adequate drainage of aggregate base of adjacent paved areas but sufficiently high to provide infiltration storage.

Other strategies can also help reduce runoff volumes and provide water quality benefits in parking areas, such as reducing paved surface area and through the use of permeable paving.

Pavement reduction can be accomplished in three main ways, including changing municipal codes to reduce parking area requirements, reducing the dimensions of each stall and then offering flexible parking areas with pervious surfaces, and by promoting shared parking areas.

Permeable paving also offers stormwater benefits to parking areas. Permeable paving is paving that contains spaces to allow a transmission of water into the aggregate base and subsoils. Runoff is temporarily stored in the base for infiltration into the subsoils and/or slow release to a storm drain system. Permeable paving reduces runoff volumes and rates, recharges groundwater and sustains base flow, and filters sediments and associated pollutants from runoff.

bioswale in a parking lot (Tellabs, Napeville, IL)
(Conservation Design Forum)



cross section of bioswale (Conservation Design Forum)

Green Roofs

Definition

Green roofs are planted roof systems atop buildings. These systems are designed to help stormwater management through the capture and temporary storage of rainwater. Green roofs are generally planted with drought and wind tolerant vegetation. These plants capture rainwater and store it in their root zones, encouraging evapotranspiration and preventing much of the water from entering the runoff system. The water leaving the roof in most cases is slowed, treated, and cooled, a benefit for downstream waterbodies.

Key considerations for the design and implementation of green roofs:

- Structural load capacity of existing roof system must be evaluated.
- Plant material, such as succulents, that are drought tolerant, should be used on lightweight "extensive" green roof systems.
- A wider range of vegetation may be used on heavier, "intensive" green roof systems that have a deeper growing medium.

Green roofs can be built in a variety of ways, but the simplest involves a relatively light drainage and filter system and a thin (2-4 inches) soil mix layer. These roofs are called *extensive systems*. More complex systems, or *intensive systems* use deeper soils to accommodate plants with greater root systems. These systems in some cases can support trees and shrubs and may have the structural capacity to support human use.

Green Roof Components

All green roofs include the following key component layers:

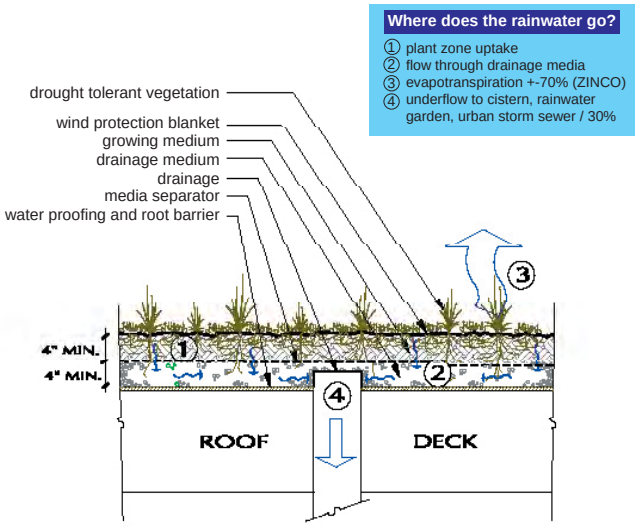
Roof structure - the load bearing capacity determines limit of growing media depth and other treatments
Waterproof membrane - a tar or rubber membrane used to prevent water from entering the building
Drainage layer - synthetic base fabric used to provide excess water an easy escape route off the roof aggregate
Growing media - a lightweight, engineered material that functions like soil
Vegetation - the most dynamic and expressive part of the roof

Benefits

- Significantly reduces runoff volumes and rates as well as thermal impacts (50 - 90% reduction in annual runoff).
- Can reduce detention needs.
- Helps to improve air quality by reducing CO2 levels.
- Alleviates urban heat island effect by cooling and humidifying the surrounding air.
- Reduces the energy requirements and cost associated with heating and cooling, through insulation.
- Creates opportunities for outdoor space as roof top gardens.
- Provides attractive views from other buildings as well as increased habitat for birds, butterflies, and other insects.

green roof (Chicago City Hall, IL) (Conservation Design Forum)

green roof can be applied on various roofs and scales (Germany)



cross section of an extensive green roof systems (Conservation Design Forum)

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